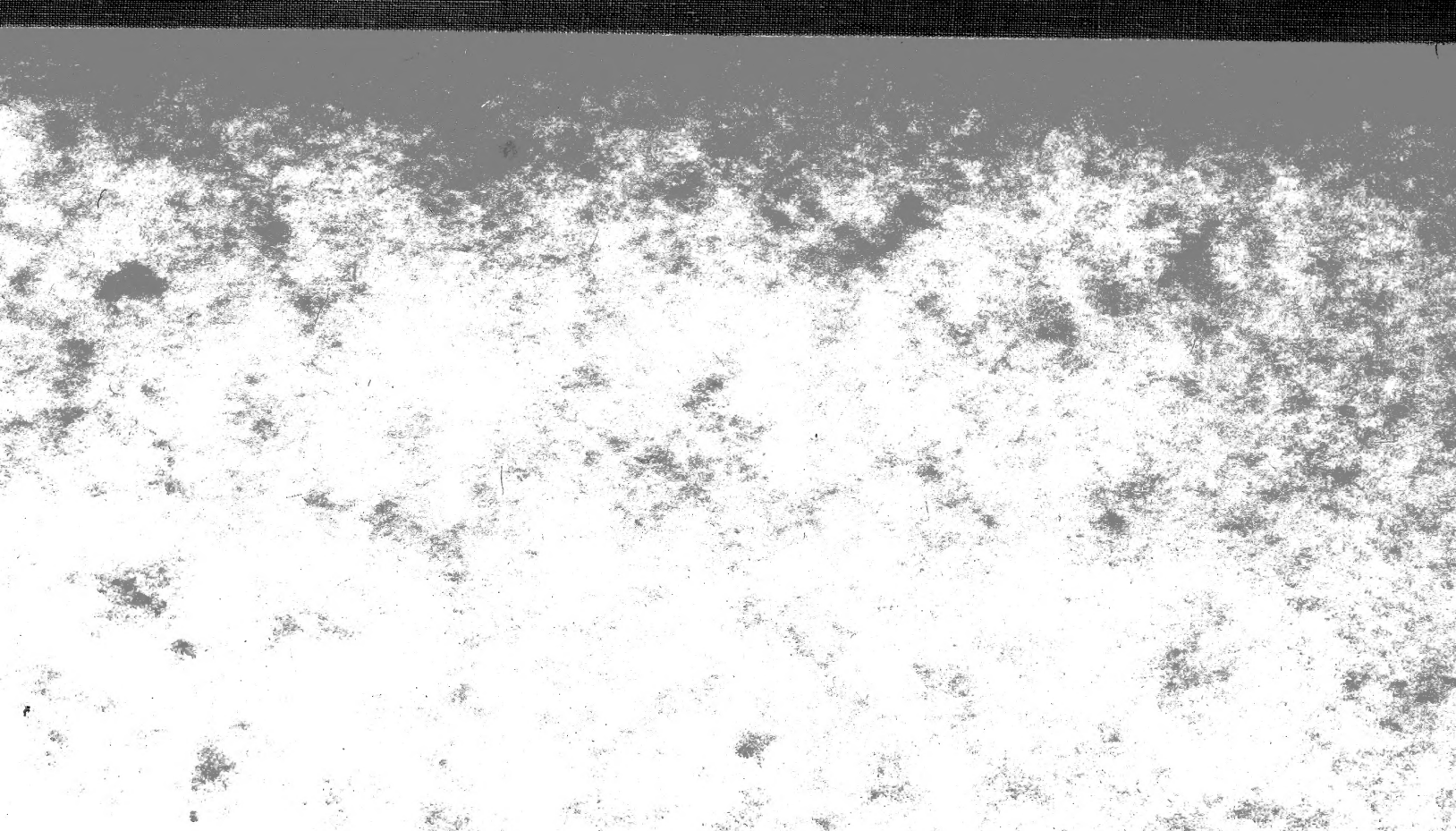

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OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1892.

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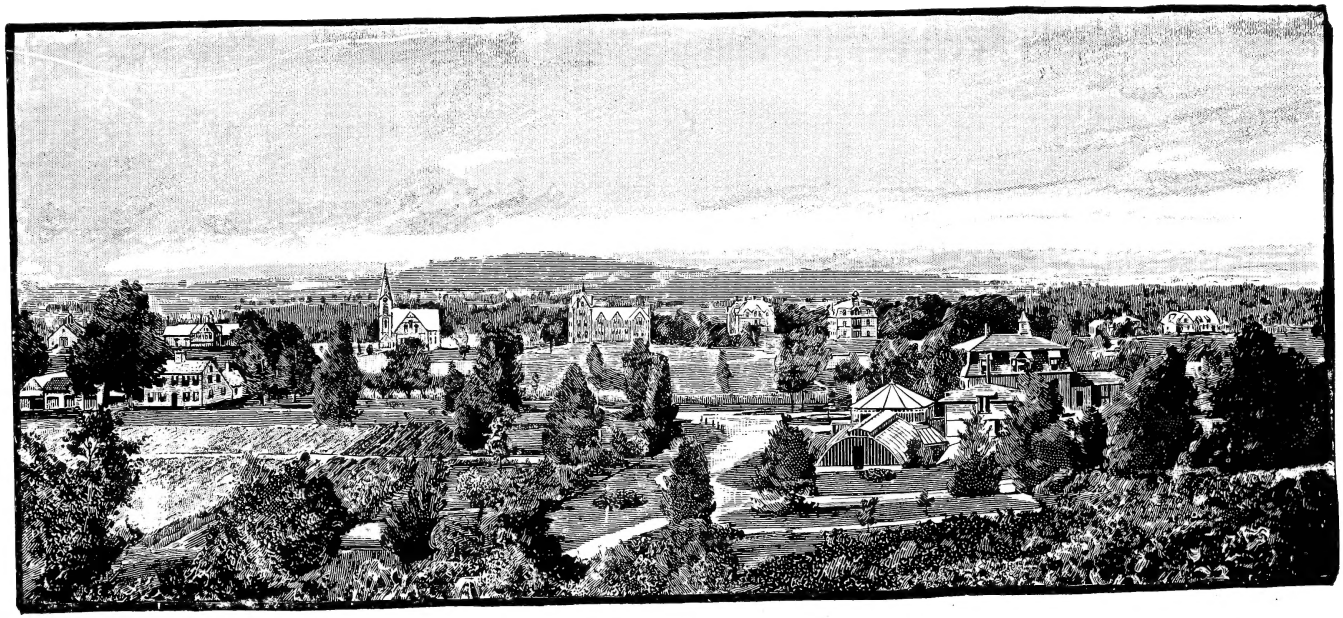

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Commonwealth of Massachusetts

Massachusetts Agricultural College,
Amherst, Jan. 14, 1892.

To the Honorable Senate and House of Representatives.

I have the honor to transmit herewith to your honorable body the Twenty-ninth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

CHARLES H. FERNALD,
Acting President.

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ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the Honorable Senate and House of Representatives.

During the past year the college has been very prosperous, though no great changes have occurred. President Goodell has been ill because of overwork, and was granted a leave of absence during the fall term, which was spent in Europe. His duties were assigned to me during his absence, and it is but just to say that the success of the fall term is due to the excellent condition in which he left the college, and to the hearty co-operation and assistance of the members of the faculty.

A fine class of forty-three students was admitted in September, making the whole number now in college larger than at any previous time in the history of the institution. This gradual growth during several years past is undoubtedly due to several causes: first, the able administration of the college; secondly, the efficient corps of teachers associated in its management; thirdly, the higher standard of scholarship required for admission, and for promotion from one class to another; fourthly, the better and fuller knowledge of the college and its aims and purposes by the citizens of the Commonwealth; and, lastly, the encouragement offered by the provisions of the labor fund.

This higher grade of scholarship which the institution now maintains will be a source of satisfaction to the graduates of the college, since it will prove an excellent recommendation for them when seeking situations, and will result in a far better preparation for agricultural pursuits. It is not the wish or purpose to crowd the dull or slow students out of college, provided they are faithful and accomplish all they are able; but it is the express purpose to compel the indolent and negligent to do good work or to leave.

The Labor Fund.

I desire once more to call attention to the good results of this most wise provision of the General Court of 1889. Permanent improvements have been made on the farm, and work has been carried on in the horticultural department that it would not have been possible to undertake in any other way. It has given the opportunity to every young man of limited means to secure an education by his own individual efforts, and the opportunity has been eagerly embraced. To this cause perhaps more than to any other may be assigned the increased numbers that have come to the college during the past three years. It is no charity, for it returns to the State twofold for every dollar expended, — first in the increased value of its property, and second in the education and training up of young men to be good and faithful citizens. The fund has been administered with great care. Those desiring to enjoy its benefits have been required to bring a certificate from some responsible fellow-townsman, certifying to the fact that it was necessary for them to work in order to gain an education. During the past year over $6,600 has been expended for labor thus performed. This has been distributed among one hundred and twenty students. The average amount earned has been from fifty to sixty dollars, while the largest amount earned by any single individual has been one hundred and fifty dollars. The labor and maintenance fund created by chapter 12 of the Resolves of 1889 expires with the present year, and it is asked for a continuance of the same, and that the appropriation be made perpetual.

Report on the Horticultural Department.

The horticultural industry of the State is of the greatest importance, and is steadily increasing in amount and value. The necessities of this department of the college are pressing, and it is asked that $8,000 may be appropriated for the following purposes, to wit: the rebuilding of the Durfee plant house, and the erection of a rose house, vegetable house and cold grapery in connection therewith, at a cost not to exceed $6,000; and the building and equipping of a tool house at a cost not to exceed $2,000. The report on this department, by Prof. S. T. Maynard, explains more in detail its needs, and the permanent improvements it is hoped will be made.

The horticultural department of the college has had a fairly prosperous year financially. The crops have been abundant and of the best quality, but prices have ruled low.

For the first time in the past ten years the peach orchard has borne an abundant crop, and many new varieties have fruited for the first time, enabling us to determine something of the comparative value of such varieties for this locality.

The land assigned for orchard purposes has now all been planted, in many cases too closely for the best results; and more land is needed, if the work of testing all of the promising new varieties be continued.

The ornamental trees and shrubs, planted in many cases for immediate effect, are in some places becoming too crowded for the best permanent growth, and will soon require heroic thinning or rearrangement.

In the botanic museum new cases have been placed for the specimens of plant growth, fruit models, etc., that have been accumulating during the past few years, and soon these collections will be arranged and properly labelled.

During the past season nearly 2,000 species of fungi have been added to the collection by purchase, and these will soon be arranged in the herbanium for reference and study.

The enlargement of the botanic laboratory, completed last season, has assisted much in the efficiency of the study of structural and physiological botany, but more apparatus is needed to complete it.

The botanic museum, stable, and other buildings connected with the department are in sad need of painting to prevent rapid decay.

In making plans for the greater efficiency of the work of the botanic and horticultural department, after a careful investigation by a committee of the trustees of the college, it was decided that the urgent needs of the department are as follows: —

Rebuilding of the Durfee plant house on an improved plan, and replacing the old system of heating with four-inch pipes by the more modern system of steam, or hot water under pressure. Also building a rose house, cold grapery and a vegetable house. This will require the expenditure of at least $6,000.

A tool-house, containing a work-room, carpenter's shop, a room with a forge and anvil, a store room and open sheds, is a necessity, as at the present time tools are stored in at least four different places, and the work of repairing must be done in the cold or in the work-rooms of the greenhouses. Such a building, with its equipment, will cost $2,000.

The draining of the garden land south of the Durfee plant house, which is too wet for profitable cultivation except in a very dry season, ought to be undertaken at the very earliest opportunity.

To put the orchards and fruit plantations, the ornamental trees and plants, and the garden land, in proper condition for the best results, a large amount of fertilizers and manures is required.

Lastly, it has been planned to devote the hillside on the south-eastern part of the grounds to the growth of all the trees, plants and shrubs, indigenous to Massachusetts, under the name of the Massachusetts Garden. To put the land in proper condition for planting will require a considerable outlay of time and money. Aside from the beautifying of the State grounds, this will prove of great profit and interest to all visiting the college, and of invaluable assistance in the study of botany.

Report of Agricultural Department.

The work in this department has been of the same general character as in the years preceding. Permanent improvements have been steadily carried forward. Stumps have been pulled, fresh ground broken up and subdued, five thousand feet of tile drains laid, and thirty-five acres ploughed and prepared for the planting of corn in the spring. In the report of Professor Brooks, herewith submitted, I would call attention to an interesting comparison of "Soiling *versus* Pasturage," and an "Account with Twenty Grade Cows."

Farm Report.

The past year has been one of general prosperity upon the farm. The area under cultivation has been larger than in any recent year, and it is believed to have been larger than in any previous year since the reduction in the area under farm management by the setting apart of grounds for the horticultural and experimental departments. This increase in area under hoed crops has been made possible by the gradual reclamation of the old pastures, the drainage of considerable tracts heretofore too wet for profitable cultivation, and the substitution of soiling crops instead of pasturage for the summer food of our milch cows. As a result, the aggregate value of the farm products has been largely increased. For this season, the total amounts to $5,525, exclusive of the crops used for soiling, which furnished green fodder for an average of thirty-two cows for five months, and must have been worth about $585. Our crops for last year were worth $4,457, in round numbers, and besides we pastured an average of about twenty cows. The products of this year, then, exceed in value those of last season by not less than

$1,200. Our sales have also been largely increased. The principal items in round numbers are: —

Milk, cream and fat calves,	$2,826
Beef,	100
Hay,	338
Lambs, wool and mutton,	225
Potatoes,	614
Pigs and fat hogs,	300
Total,	$4,403

Similar sales for last year aggregated $3,551. The squash crop for this year (a large one) is still for the most part unsold. This crop was included in last year's aggregate of sales, and it is expected that the sales of this year will exceed those of last by fully $1,000.

The number of acres in the ordinary crops of the farm was as follows: hay, 75; field corn, 14; silage corn, 10; potatoes, 10; mangels, 2½; Swedes, ½; carrots, ½; English turnips, 1; squashes, 3; and rye, 3. Besides these, we had soiling crops as follows: rye, 5 acres; clover, 1 acre; oats and vetches, 2 acres; grass, 3 acres; fodder corn, 8 acres; oats and peas, 4 acres; and barley and peas, 4 acres, — a total of 146½ acres; or, deducting land which produced two crops, 137½ acres. Most of our crops have been good and a number of them exceptionally so, although I confidently anticipate improvement in the future, as the newly reclaimed land which comprises more than one-half of our cultivable area is being gradually brought into better condition by drainage, cultivation and manuring.

Hay. — The early spring months were unusually dry, the rainfall amounting to but 1.82 inches in May, while the average for that month for the past fifteen years has been 3.41 inches. The effect was serious upon our old fields, and our crop was but about two-thirds what we usually obtain. It was secured in splendid order, the first crop being all cut before July 4, and amounting to 140 tons. The second crop, also secured in good order, amounted to 40 tons, making a total of 180 tons, or about two and two-fifths tons per acre.

Field Corn. — The fourteen acres in this crop consist for the most part of a rather heavy loam. It had been in grass without manure for two years, and was full of sorrel. It was ploughed in the early fall of last year, manured broadcast at the rate of five cords per acre in spring, and thoroughly prepared for seed by wheel-harrowing. In addition to the manure, we used per acre: muriate of potash, 140

pounds; dried blood, 70 pounds; bone-meal, 45 pounds; nitrate of soda, 60 pounds; and superphosphate, 85 pounds. Three-fourths of the mixed fertilizers were applied broadcast and harrowed in; the balance was put in the drill. Sibley's Pride of the North was the variety of corn selected, and both seed and fertilizer were very satisfactorily put in with the Eclipse corn planter. The crop was thinned to about ten inches in the drills, which were three and one-half feet apart. Very little hand work was employed in cultivation. The yield and financial standing are shown below: —

700 bushels shelled corn, at 70 cents,	$490 00	
30 tons stover, at $7,	210 00	
		$700 00
Manure, 70 cords, at $4 (one-half cost),	$140 00	
Fertilizer (three-fourths cost),	81 00	
Labor,	271 00	
		492 00
Balance in favor of crop,		$208 00

Silage Corn. — This crop occupied ten acres of our best corn land. The preceding year it had been occupied by rye, corn, mangels, potatoes, Swedes, and carrots. The rye (about one half the whole) received no manure, but the balance was all similarly and well manured. The corn following corn the year before was best, and next in quality ranked the crop after rye, potatoes, mangels, carrots and Swedes in the order named, thus indicating the exhausting nature of the root crops. This was especially marked in the case of the Swedes, after which the corn of this year was light, although the root crop of the preceding year was abundantly manured and was not an unusually heavy one. All this land was ploughed late in the fall of last year, manured at the rate of six cords to the acre during winter, reploughed this spring, and the fertilizer spread broadcast and harrowed in. We applied per acre, in addition to the manure: fish guano, 150 pounds; nitrate of soda, 100 pounds; and muriate of potash, 150 pounds.

The yield and financial standing are as follows: —

Silage, 140 tons, at $4,	$560 00	
Shelled corn, 30 bushels, at 70 cents,	21 00	
Stover, 2 tons, at $7,	14 00	
		$595 00
One-half manure used,	$120 00	
Fertilizer (three-fourths cost),	56 25	
Labor,	251 50	
		427 75
Balance in favor of crop,		$167 25

In view of the apparently small profit upon this crop, as compared with that upon the considerably poorer crop of field corn, I must again express my conviction that the customary valuation of $4.00 per ton for silage is too low for an article which contains so much grain as does that which we produce.

For substantiation of the correctness of this view I am able to refer to the results of careful experiments made at the Wisconsin Agricultural Experiment Station, which showed that the loss of dry matter in the curing of fodder corn in the field was a little greater even than the loss in the silo. Experiments at the same station have shown that for milch cows the feeding value of the dry matter in silage and in dry corn fodder is practically equal. In some experiments the silage and in others the fodder has shown a slight superiority.

That part of our field of corn put into the silos (140 tons), if stooked and husked, must have yielded us about 600 bushels of shelled grain and 32 tons of well-dried stover, which, at current prices, would have been worth $644. I have no doubt we have an equal value in the silos, which would make our silage worth $4.60 per ton, instead of $4.00, as figured.

The fact that our field furnished a surplus above the amount needed to fill our silos was taken advantage of to determine approximately the relative cost of ensiling corn and of harvesting in the ordinary way. We cut the fodder for the silo this year into three-fourths-inch lengths, using a machine a little too light for our power, and were hindered by frequent breakages, which considerably increased the cost; and yet the actual cost of cutting in the field, hauling, and cutting into the silo, was but 80 cents per ton. Our crop averaged about fifteen tons per acre, and the cost of ensiling was, therefore, $12 per acre. Such a crop will yield 150 baskets of ears and about 4 tons of stover to the acre; and with us the cost of cutting and stooking, husking and putting the corn into the crib and the stover into the barn amounts to not less than $13 per acre. The difference between the two systems, then, is not one of cost of handling; and which is the better means of utilizing the crop must depend chiefly upon the relative food value of the product secured under these different methods. In the one case we have grain on the ear and dry stover; in the other a succulent mixture of grain and stalks, which, it is true, has lost something by fermentation. It is difficult or impossible to make well-fed stock consume all of the dry stover, and there is always considerable waste, while silage is eaten up clean by most animals. I am convinced that the ordinary waste of stover more than equals the loss by fermentation in the silo; and, when it is further considered that, before stover and grain can be profitably fed, the former must be cut into short lengths

or shredded and the latter shelled and ground, the superior economy of ensiling corn over husking and handling in the ordinary way must be evident.

Another advantage incident to the practice of ensilage rather than stooking and husking is found in connection with laying down the land to grass. When the grass seeds are sown in July or August in the standing corn, which is the common practice here, and the corn is stooked and husked in the ordinary way, the grass has a much poorer chance than when the corn is cut and at once carted away for the silo. Where each stook has stood is found a spot where the grass is killed. If, as is also not uncommon, it be desired to follow corn with rye, the prompt clearing of the field for the silo is a great advantage.

Potatoes. — Ten acres of medium loam of alluvial origin just north of the "ravine" were planted to this crop. The land had been used for a pasture for some five or six years. It was ploughed in the fall, and prepared for seed by thorough wheel-harrowing in early spring. No manure was used; but fertilizers, one-half harrowed in and one-half in the drill, were employed at the following rates per acre: fish guano, 250 pounds; superphosphate, 85 pounds; bone meal 125 pounds; muriate of potash, 165 pounds.

We were ready to begin planting April 5, but a heavy snow-fall, amounting to rather over a foot, delayed operations ten days. The seed which had been cut suffered seriously by the delay, and fully one-fourth of it failed to grow. The crop was from this cause lighter than we had expected; but it was of splendid quality. It was sold in Boston, and brought from forty to fifty cents per bushel, from which freights and commission must be deducted. Financial results: —

Potatoes (net proceeds of sales),		$570 78
Three-fourths fertilizers used,	$100 25	
Labor in raising and marketing,	297 75	
		398 00
Balance in favor of crop,		$172 78

Carrots. — This crop occupied one-half acre of good land, but, requiring to be replanted, the seed was got in so late that the crop was small. It amounted to only 125 bushels of roots, which will hardly repay the cost of the labor. The soil received a good dressing of manure and a liberal application of mixed fertilizers.

Swedes. — Area in crop, one-half acre of medium loam. This was ploughed in the fall, manured during winter at the rate of seven cords

per acre. It was reploughed in the spring, the fertilizer spread broadcast and thoroughly harrowed in. The seed was planted July 1, and the crop made a magnificent growth of tops, but the development of the roots was not satisfactory. Many were hollow, and not a few rotted. The fertilizers used per acre were as follows: nitrate of soda, 150 pounds; muriate of potash, 150 pounds; superphosphate, 100 pounds. Financial standing: —

Swedish turnips, 12 tons, at $4,		$48 00
One-half manure used,	$7 00	
Fertilizer (three-fourths cost),	5 00	
Labor,	28 00	
		40 00
Balance in favor of crop,		$8 00

Beets.—The land selected for this crop, two and one-half acres, was similar to that on which the Swedes were grown, and it was similarly prepared and received equal amounts of manure and fertilizers. One acre of this land was in squashes and one acre in popcorn, the balance in potatoes in 1890. The preparation of the soil for planting was very thorough, the germination of the seed satisfactory, and the conditions for growth throughout the season highly favorable. The result was a remarkably fine crop. The yield and financial results are shown below: —

106 tons beets, at $4,		$424 00
Manure (one-half value),	$36 00	
Fertilizer (three-fourths cost),	19 00	
Labor,	115 00	
		170 00
Balance in favor of crop,		$254 00

The varieties raised were Lane's American sugar beet, and Carter's orange globe mangel.

An experiment was made upon this crop, to test the efficacy of common salt as a fertilizer. The land was divided transversely into half-acre strips, and coarse salt at the rate of two hundred pounds per acre was sown broadcast, soon after the seed was planted, upon three of these sections. The beneficial effect of the salt was apparent throughout the season, but the actual gain in yield was not large. It amounted to two and one-half tons per acre, which is sufficient to repay the cost of application some five or six times over. The benefit from the use of salt for this crop would undoubtedly be yet more striking in cases where such fertilizers as muriate of potash are not employed; for the hydrochloric acid in this must have a similar effect in unlocking plant food to that resulting from the action of the same acid in the salt.

Squashes. — Three acres of warm, medium loam, north of the "ravine," were planted with this crop, about one-fifth with Hubbard and the balance with Essex hybrid seed. Upon one acre potatoes also were planted, every third row being left out for the squashes. The results of this method of planting were on the whole satisfactory. If potatoes of an early variety are planted in good season, they finish their growth before the squashes require the land. The land in this crop received a heavy broadcast application of material from the ruins of the Hatch barn, which was destroyed by fire April 5. This barn contained a considerable quantity of nitrate of soda, muriate of potash and dissolved bone-black; and the mixed remains of these and the ashes from the fire were undoubtedly of considerable value. In addition, we used mixed fertilizers in the hill in the following quantities per acre: bone meal, 150 pounds; fish guano, 100 pounds: muriate of potash, 110 pounds. On the greater part of the field we used in each hill a shovelful of coal ashes, the beneficial effect of which in preventing the work of the borer was very marked. Where the ashes were not employed the percentage of loss of plants was much the larger, many hills being entirely destroyed. The yield and financial standing of the crop are shown below: —

25 tons squashes, at $10,		$250 00
Three-fourths cost of fertilizers used in hills,	$17 00	
Labor, raising and storing,	60 75	
		77 75
Balance in favor of crop,		$172 25

Rye. — Three acres of newly broken up old pasture were in this crop, which received in spring an application of 150 pounds of fish guano, 150 pounds of muriate of potash and 100 pounds of nitrate of soda, per acre. The yield was fairly satisfactory, and the standing of this crop is shown below: —

60 bushels grain, at 80 cents,	$48 00	
4 tons straw, at $20,	80 00	
		$128 00
Three-fourths fertilizer used,	$17 43	
Labor,	27 00	
		44 43
Balance in favor of crop,		$83 57

Besides the crops described in detail, we harvested 200 bushels of English turnips grown as a second crop after oats and vetches for fodder, and had small areas in pop-corn and in garden crops.

Soiling Crops. — These consisted of five acres of rye, one of clover,

two of oats and vetches, three of grass, eight of fodder corn, four of oats and peas, and four of barley and peas. The oats and barley with peas were grown as second crops after rye, and for them the land was manured. The rye was treated as already described for the portion harvested for grain. The oats and vetches on new and very rough land were grown on barnyard manure in moderate quantity; the fodder corn on similar land got an application of dried blood, 125 pounds; muriate of potash, 75 pounds; bone-meal, 50 pounds; and fish guano, 150 pounds per acre. Neither the clover nor the grass received any dressing this year.

The growth of all these crops was satisfactory, and we produced *green fodders* sufficient for the average number of thirty-two cows for five months on nineteen acres of land, much of which is but partially subdued. The rye comes first and produces a large growth, but is on the whole the least satisfactory food for cows, being eaten less freely than the others. We found that on our land, which is rather low and moist, oats are very liable to rust, which seriously lessens their value. This was especially true of the late crop which with peas proved much inferior to barley and peas which were in fit condition to feed until about the 20th of October. For the very latest feeding the peas should be left out, as frost kills them before it injures the barley. The most satisfactory fodder for the production of milk and cream appeared to be clover and corn. One acre of clover produced three good crops, aggregating not less than 18 tons, or sufficient to supply green food for our thirty-two cows for twelve days. Less grain is required when the green food is chiefly clover than when corn fodder is the main reliance.

Soiling versus Pasturage. — I am able to make an interesting comparison between the results obtained when land is pastured and those obtainable under the soiling system. In the season of 1890 about thirty acres of land, about four-fifths of it in good grass, the balance somewhat covered with stumps, but with much sweet feed between, was used for the pasturage of an average of about thirty cows and heifers, and the returns in cream amounted to $454.96, and in improvement to young stock possibly to $100, — a total from this land of $554.96, and it was stocked to its full capacity.

During the past year this land has been cleared of stumps, about five acres of it have been drained, and the whole brought under the plough. With the exception of that produced upon one acre of clover and three of grass elsewhere, it has produced green fodder for thirty-two cows. The proportion of such fodder coming from this land must equal four-fifths of the whole, and I will credit it with fourth-fifths the proceeds from our cows during the time they were

on green food. Grain was used both this year and last, in about equal proportion to the other food, and, as I do not make any allowance for this, the apparent credit to the land for each year is greater than the truth; but this does not affect the comparison, and the value of the manure made this year will go far towards offsetting that item, together with the cost of labor in cutting and hauling the fodder. The gross receipts from this land this year are as follows:—

Cream (four-fifths of total),	$683 52	
Squashes, 25 tons,	250 00	
Potatoes, 1,522 bushels,	570 78	
Rye and straw,	128 00	
Turnips, 200 bushels,	20 00	
Total gross receipts for 1891,		$1,652 30
Total gross receipts for 1890,		554 96
Excess for 1891 over 1890,		$1,097 34

Deducting the labor of raising the crops and the cost of the fertilizers and manure used in 1891, we have the net proceeds from these thirty acres for this year $914.47, against $554.96 for 1890. The cost of clearing the land and of drainage is not charged against the crops of this year, as this work constitutes a permanent improvement, the effects of which will be increasingly felt for a number of years. The excess in net value of the products of this year as compared with last is, however, more than sufficient to repay the full cost of clearing the land of stumps. When, then, we further consider that the condition of all this land is greatly improved, it becomes sufficiently evident that for us soiling is far preferable to pasturage for milch cows.

Farm Live Stock. — During the past year our horses, sheep and swine have maintained a high average of health, and there have been no losses except a very few of young pigs and lambs at birth; and the breeding increase of the swine and sheep has been satisfactory. From causes which we are unable completely to control, our cattle have suffered somewhat from foot-rot, which, however, we are generally able to check in its earliest stages. Our returns from this part of our stock have been satisfactory. The faulty construction of our barn, making it an impossibility to keep the air of the cow stable pure, has been the indirect cause of some losses among our pure-bred stock. The fine Holstein-Friesian bull, Pledge's Empire, died suddenly from *tetanus*, the cause of which was a mystery. His place at the head of our Holstein-Friesians has been taken by Prince of Concord, a bull from one of the best butter families of the breed. His dam has a record of about thirty pounds

of butter in seven days. Throughout the year we have continually culled out inferior animals, and the result is a high average of excellence throughout our herd.

Milk Records of Pure-bred Cows. — As evidence of the quality of our stock, permit me to report the milk yield of a few of our best pure-bred cows. In each case the highest record made within twelve months is given: Ayrshires, — Myrca, 8,100 pounds, 14 ounces; Myrca Clifton, 9,283 pounds, 6 ounces; Amelia Clifton, 8,614 pounds, 4 ounces; Holstein-Friesians, — Beth Hoorn, 13,206 pounds, 6 ounces; Cornelia Artis, 11,830 pounds, 10 ounces; Cornelia Pledge, 8,555 pounds; Shorthorn, — Dulcibella, 6,851 pounds, 11 ounces; Guernsey, — Fanny, 6,687 pounds, 6 ounces; Jersey, — Faith of Deerfoot (nine months), 4,869 pounds, 3 ounces.

Grade Cows. — As further evidence of the quality of our stock and the results of our system of feeding, I include the following account with the twenty grade cows purchased in October of last year.

Account with Twenty Grade Cows.

Dr.

To cost of cows,	$1,000 00
To net cost of feed, November, 1890 to May 1891,	396 23*
To net cost of feed, May, 1891, to November, 1891,	355 25
Total,	$1,751 48
Profits on investment,	700 07
	$2,451 55

Cr.

By 37,628 spaces cream, at 3¾c,	$1,411 05
By 12,480 gallons skim-milk, at 2 cents,	249 60
By calves sold from herd,	40 90
By value of cows at close of year,	750 00
	$2,451 55

The individual standing of this lot of cows is more clearly brought out by the table below: —

Average gross cost of feed consumed,	$69 30
Average net cost of feed consumed,	37 57
Average value of product,	83 03
Average net profit,	45 46
Average milk yield per year,	7,019 pounds 2 ounces.
Average butter yield per year,	308½ pounds.
Average age of cows,	8 years.
Average weight of cows,	990 pounds.

* The net cost of feed is obtained by deducting four-fifths of the fertilizer value from the gross cost.

The average butter yield for the cows of the State of New York is estimated by Dr. Peter Collier to be below 130 pounds per annum, and it is seldom that even a herd of pure-bred animals numbering twenty makes an average equaling that of these grades. When it is further stated that one of these cows added extremely little to the aggregate product on account of foot-rot, it will be seen that the performance of these animals has been rather extraordinary. The statement of foods used and of their market and fertilizer values is given below: —

Winter Feed of Twenty Cows (November 1 to May 18).

		Fertilizer Value. Per Ton.	Fertilizer Value. Total.
18 tons hay, at $12,	$216 00	$6 48	$116 64
9 tons corn stover, at $6,	54 00	3 19	28 71
38 tons silage, at $4,	152 00	1 64	62 32
9 tons beets, at $3,	27 00	1 14	10 26
6 tons bran, at $20,	120 00	14 58	87 48
3 tons cotton-seed meal, at $26,	78 00	26 25	78 75
2 tons gluten meal at $28,	56 00	19 01	38 02
1 ton corn meal, at $32,	32 00	7 85	7 85
1,200 pounds linseed meal (new process), at $27,	16 20	22 80	13 68
Total cost of feed,	$751 20	Total fertilizer value,	$443 71

Summer Feed of Twenty Cows (May 18 to Nov. 1, 1891).

		Fertilizer Value. Per Ton.	Fertilizer Value. Total.
15 tons of rye, at $2.50,	$37 50	$1 25	$18 75
12 tons of clover, at $4,	48 00	2 48	29 76
12 tons of vetch and oats, at $3.50,	42 00	1 54	18 48
46 tons corn stover, at $2.50,	115 00	1 25	57 50
15 tons { barley and peas, / tons { oats and peas, } at $3.50,	52 50	1 54	23 10
9 tons beets, at $3,	27 00	1 14	10 26
10 tons hay, at $12,	120 00	6 48	64 80
3½ tons bran, at $21,	73 50	19 58	51 03
2½ tons linseed meal, at $27,	67 50	22 80	57 00
1 ton gluten meal, at $28,	28 00	19 01	19 01
60 weeks' pasturing, at 40 cts.,	24 00		
Total cost of feed,	$635 00	Total fertilizer value,	$349 69

Our stock at present consists of the following animals: —

Horses. — Percherons: one stallion, one mare, two stallion colts and one mare colt; one three-fourths blood Percheron mare colt, two half-blood Percheron mares and three geldings, — total, eleven.

Cattle. — Ayrshires: one male, ten females; Shorthorns: two females; Guernseys: one male; Holstein-Friesians: two males, nine females; Jerseys: two males; grades: thirty-four females. Total: six bulls, fifty-four cows and heifers.

Sheep. — Southdowns: one ram, twenty-four breeding ewes, six ram lambs and six ewe lambs; total, thirty-seven.

Swine. — Small Yorkshires: one boar, two breeding sows and thirty-three pigs of all ages; Tamworths, one boar and one sow.

Equipment. — The only important additions to our equipment during the year are as follows: Champion self-binding reaper, Keystone hay-loader, Buckeye chain-gear mower, Aspinwall potato-planter, Yankee swivel-plough, and Yankee disc harrow. All these have been acquired by purchase, and have been found to do their work in a satisfactory manner. Especially would I commend the hay-loader and the potato-planter.

Permanent Improvements.

Our work in this direction, as last year, has been chiefly expended upon the old pastures on the western side of the farm. It has been mainly concentrated upon the northwestern section, which will undoubtedly prove the best land on the farm, as the soil is naturally of a very superior character. Here, five acres, from which the wood, a heavy growth of pine, was cut several years ago, have been cleared of stumps. This required the uninterrupted work of three men working with stump-puller and Atlas powder cartridges for more than two months. Rather more than seven hundred stumps were taken out, and, with the assistance of men and teams, they were piled and burned. The land was thoroughly broken up, and, though far from smooth, and still containing some roots, its further improvement will be comparatively easy. A fine crop of fodder corn was grown upon it with little labor, and it was seeded to clover for soiling purposes in August. The seed made a good start, and a large amount of the most valuable green fodder may be confidently anticipated from this land next season.

Besides the work on this lot, a considerable number of scattered tumps have been removed from other portions of this land, which are being broken up for the second time. Some thirty-five acres of it have been ploughed this fall. This portion is now entirely free from stumps, and is one of the finest fields to be found in this part of the State. Most of it will be planted next year with corn for the silo and crib.

We have put in tile drains in various parts of these fields this year wherever they seemed to be most required; but in all cases in accordance with a system which will eventually underlay this entire tract, wherever not naturally well drained, with tiles. The total length of such drains put in this year is rather over five thousand feet, or nearly a mile.

A small amount of new fence has been built; roads have been improved, and a new silo has been put into the barn between the two already there.

I cannot close without again calling attention to the fact that, but for the labor fund, under the provisions of which much of our work is performed by students, the work of improvement upon the farm must come to a standstill, unless we receive much larger annual appropriations than at present. This fund is not a charity. The young men *earn* the money they receive, and the State receives a money equivalent in the improvement of its property, while the benefit it will derive from the lives of increased usefulness made possible through the education these young men are enabled to obtain is incalculable.

In conclusion, it gives me pleasure to testify to the hearty support on the part of both superiors and subordinates which my efforts in the management of the farm have always received; and especially must I commend the work of my superintendent, Mr. F. S. Cooley, whose active and intelligent interest and executive management have contributed largely to that measure of success which we have been able to attain.

William P. Brooks,

Professor of Agriculture.

The Experiment Department.

At no period in the history of the station has its influence been more widely felt, or its work more fully appreciated by the farmers of the Commonwealth. The divisions, particularly of horticulture and entomology, have been overwhelmed with correspondence.

Five bulletins, in editions of eleven thousand, have been issued during the year on the following topics: —

Directions for the use of fungicides and insecticides.

Experiments in greenhouse heating, over *versus* under bench piping.

Special fertilizers for plants under glass.

Report on varieties of strawberries.

Report on varieties of blackberries and raspberries.
Report on fertilizers for corn.
Report on strength of rennet.
Report on hay caps.
Report on Flandres oats.
Report on prevention of potato rot.
Report on fungicides and insecticides on fruits.
Report on seventeen of the more common injurious insects.

In addition to the above, a monthly bulletin, in a limited edition of three hundred copies, has been issued, covering the entire meteorological data for each day.

The analyses performed for this department by the State experiment station during the past three years are herewith submitted in tabulated form : —

	1889.	1890.	1891.
Ash analysis,	1	1	2
Fertilizer analysis,	11	25	24
Fodder and ash analysis,	71	121	68
Fodder analysis,	0	24	6
Milk analysis,	0	62	2
Determination of rennet value,	18	18	0
Determination of sugar,	20	0	0
Moisture determination,	11	106	459
Moisture and starch determination,	0	0	45
Fungicides and insecticides,	5	15	10

The burning, April 5, 1891, of the barn erected for experiment purposes, together with the loss of valuable data and materials, has proved a serious hindrance to the work undertaken in the agricultural division. It is now being rebuilt, and will be completed in time for the next season's operations.

The specific work of the different divisions during the year is briefly summarized in the reports of the several officers, herewith submitted : —

The Entomological Division.

The life-history of the bud moth *(Tmetocera ocellana)* has been completed and published in Bulletin No. 12, together with methods for its destruction. In the same bulletin were also published, with illlustrations, the life-histories of spittle insects, the squash bug, the pea weevil, the bean weevil, the May beetle, the plum curculio, the onion maggot, the cabbage butterfly, the apple-tree tent caterpillar, the forest tent caterpillar, the stalk-borer, the pyramidal grape-vine caterpillar, the grape-vine moth, the codling moth, the cabbage-leaf miner and the gartered plume moth.

The studies on cranberry insects have been continued during the summer at the insectary, and also on the bogs of Barnstable and Plymouth counties during the months of July and August. The work has not been completed, but a preliminary bulletin on the subject will soon be issued. Experiments were performed with Paris green and London purple on cranberry vines, to determine how large an amount may be used without injury to the vines, and also how small an amount will prove destructive to the vine worm, the results of which will appear in the preliminary bulletin.

A series of experiments was performed with Paris green on apple-trees, to ascertain what conditions of weather cause the Paris green to affect the foliage the most unfavorably.

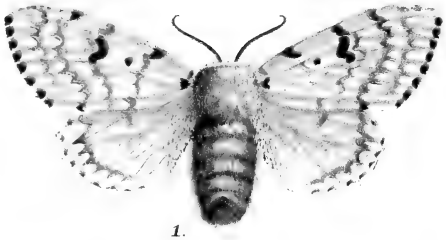
Experiments were made with kerosene emulsion on red spiders and plant lice on rose bushes.

A series of experiments was made to ascertain the smallest proportion of Paris green in water that would kill apple-tree tent caterpillars in their different molts, and also what proportion would prove the most successful in destroying them.

Six Barnard moth traps were kept in the garden and orchard during the season. From these the insects were taken each day and determined, in order to ascertain whether the beneficial effect of the traps in collecting injurious insects was offset by the number of useful insects destroyed.

The work on the card catalogue of insects and also on the biological collection for the insectary has been continued as time and circumstances permitted.

Much time has been given to the scientific supervision of the work of destroying the gypsy moth in the eastern part of the



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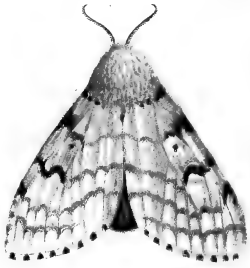

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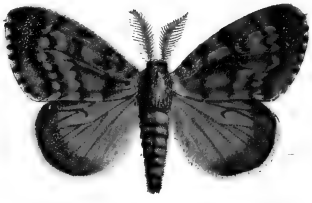

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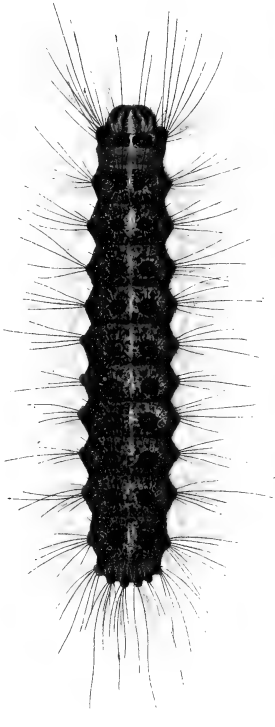

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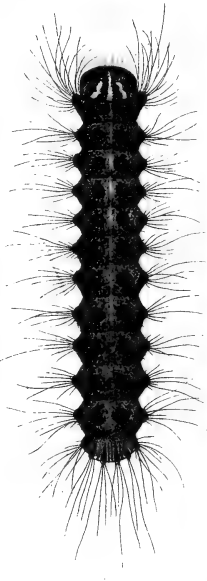

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Drawn by Joseph Bridgham.

Heliotype Printing Co. Boston.

GYPSY MOTH.

EXPLANATION OF PLATE I.

GYPSY MOTH (Ocneria dispar, L.)

Fig. 1. — Female with the wings spread.
2. — Female with the wings folded.
3. — Male with the wings spread.
4. — Male with the wings folded.
5. — Pupa.
6. — Caterpillar. } Full grown.
7. — Caterpillar. }
8. — Cluster of eggs on bark.
9. — Several eggs enlarged.
10. — One egg greatly enlarged.

State. This insect was accidentally introduced into Medford twenty-three years ago, and has spread from that place till it has now been found in more than twenty towns and cities. The moths emerge from the pupal stage in July, and, after mating, the female (plate 1, figs. 1 and 2) lays her eggs (figs. 9 and 10, enlarged), in a cluster on the bark of trees (fig. 8) and in various other places. These egg clusters are covered with very fine yellowish hairs from the under side of the abdomen of the female, and do not hatch till the following May. As soon as the eggs hatch, the young caterpillars feed on the leaves of nearly all species of plants, and have proved especially injurious to fruit and ornamental trees. They grow rapidly and reach maturity in about six weeks, when they vary somewhat in size and appearance, as shown in figs. 6 and 7. They then change to the pupal stage (fig. 5) and in about two weeks the moths emerge. The males (figs. 3 and 4) differ from the females both in size and color.

During the past season several different species of parasites have been discovered attacking the gypsy moth, and these have been collected and referred to the best authorities for determination. Some of them prove to be new to science, while others are among the most useful in holding our common native insects in check.

This is undoubtedly one of the most dangerous insect pests that has threatened our Commonwealth and country, and every possible measure should be adopted for its destruction. For two years past the State has made appropriations for the extermination of this insect, and most vigorous efforts are being made in the infested towns to accomplish this purpose. It is highly important that our citizens in all parts of the Commonwealth should be able to recognize the insect in each of its stages, so that, if it should be found in any new localities, it may be reported to the gypsy moth committee in Malden, Mass.

To aid in recognizing this insect the plate given herewith has been prepared, and also twenty-four boxes, each containing a cluster of the eggs, three different sizes of the caterpillars inflated, a pupa, a male and a female moth with the wings spread and one of each with the wings closed, have been put on exhibition in the infested towns for the information of the people.

The Meteorological Division.

The work in the Meteorological department has been a continuation of that begun in previous years. The object for which the observatory was established has been constantly kept in view; namely, the gathering of useful meteorological data and its systematic arrangement, in order to facilitate the study of climatic changes and their direct bearing upon agriculture. A careful register of all meteorological phenomena and a full and minute record of every day since the establishment of the observatory have been kept for future reference. The importance of such records must be apparent, for all the peculiarities of the weather in any locality do not manifest themselves in a season. Natural conditions change and corresponding results follow; extreme drought, copious rains, heavy snows, high and low mean temperatures are periodical, and occur as the result of cyclical atmospheric changes. Hence our knowledge of climatic and recurring local weather changes is not obtained from observations made for a few years, but accurate and reliable deductions can only be drawn from data covering at least a period of half a century.

A careful record of the mean rainfall and temperature at Amherst has been prepared from the writings of the late Professor Snell of Amherst College, who began work in this direction in 1836, so that the observatory is now in possession of an unbroken chain of data covering a period of fifty-five years.

Bulletins containing a daily and monthly summary of observations are issued every month, and at the close of each year a summary for the twelve months is prepared; thus the more important results are placed in a condensed and useful form. The bulletins are sent to meteorological societies and signal stations in the various States, also to voluntary observers and other individuals who may apply for them.

In addition to the regular routine work of the observatory, a series of experiments with dynamical electricity and its influence upon vegetable growth has been undertaken. These experiments have been in progress for two years, and further observation will be made in this direction. Preparations are now in progress for testing various seeds, submitted to the influence of electric currents of different degrees of intensity,

before planting, to ascertain whether seeds thus treated develop more rapidly in the soil, or whether their vitality is partially or wholly destroyed. For the lack of funds, experiments in this department must necessarily be carried on in a small, economical and inexpensive way, and the latter is often a detriment to the best results. It is hoped that means will soon be provided whereby more elaborate field experiments can be made concerning the direct and indirect influence of atmospheric electricity upon the growth and development of plants.

Since the agricultural department assumed charge of the weather bureau, the hearty co-operation of voluntary observers has been solicited, and daily forecasts and storm warnings promised to all those in country places who would display flags. That the movement is a wise and important one cannot be questioned, for many cases already can be cited where valuable crops have been saved from destruction through the timely warnings of the signal service; and it is the desire of the latter that these official forecasts should reach the remote as well as the more accessible agricultural districts. While this may not be fully realized, yet a great deal can be done toward furthering the work, and important service rendered the farmer in helping him to protect his crops. It seems proper that the observatory, situated as it is on the college grounds, in a rich and fertile agricultural section, should be provided with the necessary means for communicating storm and frost warnings to the surrounding farmers.

It was recommended in the last annual report of this department that money be appropriated for flags used for signalling and telegraph instruments to be placed in the observatory, that direct communication might be had with the Weather Bureau at Washington. The expense of such equipment has been estimated at two hundred and fifty dollars. Arrangements were also made with the authorities at the central office to furnish this department with the official weather forecasts twice daily, and free of charge.

The Agricultural Division.

The Japanese millets mentioned in the last annual report, together with two other species of millet and a number of varieties of Soja bean, have been under further trial. The millets

show remarkable cropping capacity. *Panicum italicum* in half-acre plots has yielded in one instance at the rate of seventy-two bushels of heavy seed and two and one-sixth tons of straw, and in another at the rate of seventy-six bushels of seed and two and one-fifth tons of straw per acre. This straw will be analyzed, but from its appearance it is judged that it must equal corn stover in feeding value. An experiment in feeding will be undertaken this winter. Another millet, *Panicum crus galli*, yielded at the rate of forty-two and a half bushels of seed and nearly seven tons of straw to the acre; and another, *Panicum miliaceum*, at the rate of ninety and eight-tenths bushels of seed and six and one-half tons of straw. The latter when green was eaten with all the avidity which cattle usually show for green corn fodder, and promises to be a valuable crop for soiling or for the silo.

Several of the varieties of Soja bean, *Glycine hispida*, which have been under cultivation, prove well adapted to our soil and climate, and on soil of medium quality have yielded in different years from about twenty-five to thirty-five bushels to the acre. About eight bushels of these beans were ground into a fine meal by the local miller last winter, and an experiment in feeding the meal to milch cows would have been undertaken, had not the destruction of our barn by fire prevented. This experiment will be undertaken the present winter, upon a smaller scale, made necessary by the loss of our stock of seed.

White mustard seed at the rate of about sixteen bushels per acre has been raised, and was ripe in season for use in seeding for green manuring upon stubble land and in standing corn. Careful experiments in the use of this crop as a nitrogen conserver and soil improver have been begun.

Hemp of two varieties and flax of three have been successfully raised; but the experiment with flax, which occupied three-fourths of an acre, has demonstrated the impossibility, at present prices, of growing the crop at a profit in this section.

Black Tartarian oats and early race-horse oats from Japan, and a large number of varieties of English and American wheats, both winter and spring, have been under trial upon a small scale. The most striking point brought out by these trials is the unsuitability of English wheats for this climate. They are very late and unusually susceptible to rust. Full reports on these crops will be published in future bulletins.

The soil tests with fertilizers for corn in twelve localities of the State reported in Bulletin No. 14 confirm in a striking manner the conclusions presented in Bulletin No. 9. Both sets of experiments indicate the necessity of more potash than is usually employed for the growth of this crop, The grand average increase in hard corn and stover per acre in 1890, taking all experiments into account, was as follows: —

For potash, hard corn, 11.3 bushels; . stover, 1,308 pounds.
For phosphoric acid, hard corn, 4.7 bushels; stover, 389 pounds.
For nitrogen, hard corn, 3.6 bushels; . stover, 162 pounds.

Similar soil tests have been carried out in five localities this year with oats and potatoes. They show that oats, in particular, differ in a marked degree in their requirements from corn, being greatly benefited by an application of nitrogen in the form of nitrate of soda.

The soil tests of two years having led to the conclusion that potash should be more largely used both with fertilizers and manures for corn, experiments have been carried out to test the correctness of this conclusion. In two experiments, occupying one-half an acre each, manure alone, applied at the rate of $30 worth per acre, gave at the rate of about 57 and 56 bushels respectively of corn, and 3,840 and 3,800 pounds of stover per acre; while manure and potash, applied at the rate of $17.50 worth per acre, gave crops of about 54 and 52 bushels respectively of corn, and 3,780 and 3,660 pounds of stover per acre. The larger application (double) of manure alone gave slightly the larger yields; but the difference was by no means sufficient to pay for the larger amount of manure used. The difference in cost of manures was $12.50; in crops, about three bushels of corn and one hundred pounds of stover.

An experiment with fertilizers, to test the conclusion alluded to above, was carried out upon another half acre. Fertilizers containing the average amounts of nitrogen, potash, and phosphoric acid found in six special corn fertilizers in the market, and costing $13.66, gave a crop at the rate of about 55 bushels of hard corn and 4,100 pounds of stover; while a fertilizer with less nitrogen and phosphoric acid and much more potash, and costing $10.70, gave at the rate of 56 bushels of corn and 4,300 pounds of stover, — a slightly superior crop at considerably less

cost. A similar experiment with millet occupied another half acre, and this also showed the superiority of the cheaper combination of fertilizers.

The two experiments with fertilizers just alluded to were designed to serve also as a basis for comparison of millet and corn as grain crops. The millet yielded at the rate of about seventy-five bushels of seed and two tons of straw per acre; the corn fifty-six bushels of grain and a little over two tons of stover. The cost of labor was the greater for the millet; but until the crops are analyzed it is impossible to make an exact comparison. The millet has been ground, and makes an excellent meal.

The grand average of the milk analyses of the two samples (morning and night) of the milk of all the cows in our herd made in December, 1890, was 13.17 per cent. total solids and 4.11 per cent. fat, thus being a little above the legal standard in this State. The milk of the Ayrshires (six cows) averaged 13.29 per cent. solids and 3.78 per cent. fat; Holstein-Friesians (five cows), 12.10 per cent. solids, 3.26 per cent. fat; Shorthorns (four cows), 13.19 per cent. solids, 4.04 per cent. fat; Jerseys (three cows), 13.91 per cent. solids, 4.96 per cent. fat; Guernsey (one cow), 16.36 per cent. solids, 6.79 per cent. fat; grades (twenty-one cows), 13.23 per cent. solids, 4.18 per cent. fat.

Horticultural Division.

The work of this division has been carried on according to the plans made at the beginning of the year, the results of which have been published in full, or in part, in the quarterly bulletins.

In Bulletin No. 11 are given the results of the use of fungicides and insecticides combined, for the destruction of insects and fungous growths attacking the same kinds of crops. In Bulletin No. 13 is given full instruction for the use of fungicides, and also fungicides and insecticides, when they can be successfully and economically combined, based upon the work of this station and the facts established by workers in the same line connected with other stations.

During the past season duplicate experiments have been conducted by responsible parties in different parts of the State, and,

as far as results have been reported, many important facts have been obtained. The object of this work has been twofold: first, to increase the certainty of accurate results by having the work done by specialists, and in different parts of the State; and second, to extend as much as possible the knowledge of the methods of using fungicides and insecticides.

Among the results obtained the past season from all sources are the following: —

It has been demonstrated beyond question that the apple crop can be saved from serious injury by the apple scab, and the injury from the larvæ of the codling moth can be largely prevented.

That the rotting of the fruit of the peach and plum before fully ripe can be largely prevented, but in the use of copper salts on the peach foliage very dilute solutions must be made.

That the pear and plum leaf blight can also be largely prevented, and that the plum wart, so destructive to our plum trees, can be prevented.

That the potato blight, and the rot that soon follows, can be largely prevented by using solutions of copper, and that, by the use of Paris green in the same mixture, the potato beetles are more certainly and economically destroyed than in any other way.

Extensive experiments have been made in protecting peach buds from injury by cold; but, as the buds unprotected were not injured, no results were obtained the past season. We have, however, demonstrated that large trees, which have not been especially prepared for the purpose, can be laid down upon the ground at a very small expense and without injury.

In the green-houses, the testing of the over-bench piping, as compared with the under-bench, resulted somewhat in favor of the latter, although the comparison for one season only is not sufficient to establish the matter beyond a doubt.

The results of the comparative tests of the leading varieties of fruits have been of much interest. Among the apples, the Haas has proved for several years to be a very productive, hardy and handsome autumn apple of good quality, and the Excelsior peach, although medium in size, is of fine quality, and for the past five or six years has proved more hardy than any other variety. Among the plums, the Abundance, one of

the Japanese varieties, is very fine in quality, of good size, and very productive.

The one grape that stands out as having especially valuable qualities, among the many new kinds, is the "Winchell" or "Green Mountain." This is a *very early*, green grape of medium size and growth of vine, but of very fine quality, and, so far, free from disease.

Among the small fruits, the red raspberry known as Thompson's Early Prolific has proved the earliest variety upon the grounds. It is hardy, of vigorous growth and good quality, and, if it proves as productive as the Cuthbert or Marlboro, it will be one of our most valuable varieties. Of the strawberries, those taking the highest rank are the "Beder Wood" and "Parker Earle," the first a very early, perfect-flowered variety, valuable for home use or market, grown in the matted row or in the hill, and the second a late variety, growing naturally in hills, yet producing runners enough for its rapid propagation.

An effort is being made to test *all* the new varieties of large and small fruits, and such of the vegetables and flowers as may be sent to us for trial, but with limited means this is all that it has seemed advisable to undertake. The testing of *all* varieties of vegetables and flowers, in a comparative way, is of great importance to the people who cannot afford to spend the time and money necessary for this work.

One of the pleasant duties connected with the work of this department has been answering the numerous questions sent to us upon all horticultural subjects, and receiving reports of the interesting results obtained by those who are experimenting in a private way. All such questions or reports of results are earnestly solicited, and full credit will be given to the parties communicating them.

TREASURER'S REPORT.

ANNUAL STATEMENT OF THE HATCH FUND.

For the Year Ending June 30, 1891.

Cash received from the United States,		$15,000 00
Cash paid, salary,	$6,885 80	
library,	580 02	
labor,	1,697 00	
freight and express,	111 27	
printing,	1,681 45	
incidentals,	1,980 72	
supplies,	1,238 66	
general fittings,	199 15	
scientific instruments,	381 80	
postage,	37 46	
furniture,	96 05	
travelling expenses,	110 62	
		$15,000 00

AMHERST, MASS., Jan. 2, 1892.

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1891, and have found the same well kept and correctly classified as above; and that the receipts for time named are shown to be $15,000, and the corresponding disbursements $15,000. All of the proper vouchers are on file, and have been by me examined and found correct, there being no balance to be accounted for in the fiscal year ending June 30, 1891.

J. HOWE DEMOND, *Auditor.*

Cash received for insurance on buildings and contents burned during the year, belonging to the station,	$3,470 00
Cash paid out for rebuilding,	1,624 63
	$1,845 37

JAN. 2, 1892.

This is to certify that I have this day examined the accounts of the cash received and paid on money received for insurance on Hatch Agricultural building, and find balance of cash on hand of $1,845.37.

J. HOWE DEMOND, *Auditor.*

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College.

FRANK E. PAIGE, *Treasurer.*

I hereby certify that Frank E. Paige is the treasurer of the Massachusetts Agricultural College, and that the above is his signature.

[Seal.] HENRY H. GOODELL,
President Massachusetts Agricultural College.

GIFTS.

From Sir JOHN B. LAWES of England, — Nine volumes publications of the Rothamsted Experiment Station.

Dr. J. H. GILBERT of England, — One volume of "Occasional Lectures on Agricultural Chemistry."

ROBERT WARRINGTON of England, — Twenty-one pamphlets, results of investigations at the Rothamsted Experiment Station.

EDGAR H. LIBBY (M. A. C., '74) of New York City, — Thirty-eight volumes and six pamphlets on agricultural and horticultural subjects.

WILLIAM B. COURT of Montreal, Canada, — Forty-two volumes miscellaneous.

CHARLES SMITH of Amherst, — Six volumes State documents.

AMASA NORCROSS, Esq., of Fitchburg, — Six volumes official records of the war.

RODNEY WALLACE, Esq., of Fitchburg, — Three volumes government publications.

JOSEPH E. POND, Esq., of North Attleboro, — Four volumes bee journals.

JOHN W. CLARK (M. A. C., '72) of Columbia, Mo., — Transactions Missouri Horticultural Society.

JOHN AITKEN, Esq., of Darroch, Falkirk, Scotland, — Two monographs on dew and hoar frost.

AUSTIN PETERS (M. A. C., '81) of Boston, — "Etiology of Outbreak of Disease among Hogs."

Hon. GEORGE F. HOAR of Worcester, — Three volumes U. S. Geological Survey.

Dr. F. W. DRAPER of Boston, — Report of State Board of Health.

Miss ELEANOR A. ORMEROD of Spring Grove, England, — Report of observation of injurious insects.

Prof. H. A. FRINK of Amherst, — "An Address Commemorative of Richard H. Mather."

E. W. ALLEN (M. A. C., '85) of Washington, D. C., — Holzgummi, Xylose und Xylonsaüre.

WM. S. LYONS of Anaheim, Cal., — Report California State Board of Forestry.

Mrs. GEORGE A. BLACK of Portland, Me., — Land mammals of New England.

Dr. FRANK S. BILLINGS of Lincoln, Neb., — Three pamphlets on veterinary subjects.

Hon. Charles Whitehead of London, England, — Report of intelligence department on injurious insects and fungi.

Dr. Daniel Draper of New York City, — Report of New York Meteorological Observatory, 1891.

Dr. T. Wesley Mills of Montreal, Canada, — "Squirrels, their Habits and Intelligence."

J. H. Tryon of Willoughby, O., — "Practical Treatise on Grape Culture."

Chas. Turrill, Esq., of San Francisco, Cal., — Three volumes Viticultural Commission.

The Under Secretary for Agriculture of Brisbane, — Annual Report Department of Agriculture, 1890-91.

The Director of Land Records and Agriculture of Madras, India, — Agricultural Bulletins, 1891.

Henry Adams of Amherst, — Samples of drugs commonly used in veterinary practice.

Fred H. Fowler (M. A. C. '87) of Waverly, Rhetorical prizes for 1892.

Also the following papers and periodicals from the publishers: "The Massachusetts Ploughman," "The American Cultivator," "The New England Farmer," "The American Veterinary Review," "The American Garden," "The Poultry Monthly," "The Mirror and Farmer," "The American Grange Bulletin," "The Farm and Home," "The Berkshire Courier," "The Home Farm," "The Ohio Practical Farmer," "The Orange Judd Farmer," "The New England Homestead."

A legacy of five thousand dollars has been left the college by Mr. T. O. H. P. Burnham of Boston, but we understand that there is some doubt of its being received, as the heirs are contesting the provisions of the will. It would seem fitting that the college be represented by its proper officers before the courts.

I desire to call your attention to the reports of the professors of mental and political science and military science herewith submitted; also to the reports in the experiment department; and to a paper on "Military instruction in Colleges," by Lieut. Lester W. Cornish; and one on "Tuberculosis," by Dr. James B. Paige.

Respectfully submitted,

Charles H. Fernald,
Acting President.

TREASURER'S REPORT.

FRANK E. PAIGE, *Treasurer of Massachusetts Agricultural College, for the Year ending Dec. 31, 1891.*

	Received.	Paid.
Cash on hand,	$3,688 34	–
Term bill,	5,317 78	$2,197 95
Botanical,	4,756 35	5,210 91
Farm,	5,515 12	9,197 87
Expense,	47 19	5,875 13
Laboratory,	649 07	483 22
Salary,	–	17,816 60
Library Fund,	371 01	371 01
Endowment Fund,	11,281 96	–
State Scholarship Fund,	15,000 00	–
Hills Fund,	601 56	662 72
Grinnell Prize Fund,	45 00	65 00
Whiting Street Fund,	51 15	–
Mary Robinson Fund,	60 44	55 00
Gassett Fund,	42 94	50 00
Extra instruction,	–	384 00
Labor Fund,	5,000 00	6,630 97
Insurance,	–	11 19
Reading-room,	–	124 35
Advertising,	–	305 00
Cash on hand Dec. 31, 1891,	–	2,986 99
	$52,427 91	$52,427 91

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Grinnell Prize Fund,	$20 00
Mary Robinson Fund,	188 18
Hills Fund,	17 53
Labor Fund,	1,148 06
Whiting Street Fund,	163 76
Gassett Fund,	1 76
Term Bills,	124 59
General fund of College,	1,323 11
	$2,986 99

CASH AND BILLS RECEIVABLE DEC. 31, 1891.

Farm,	$3,464 09
Term bills,	1,320 26
Botanical,	359 48
Laboratory,	336 55
Cash on hand of general funds,	1,323 11
	$6,803 49

BILLS PAYABLE DEC. 31, 1891.

Botanical account,	$11 56
Expense,	468 99
Farm account,	4,788 46
Labor fund,	302 21
Term bill account,	59 70
	$5,630 92

VALUE OF REAL ESTATE.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

Buildings.

	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures,	800 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm-house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed purchased with farm,	10,000 00	
		196,340 00
		$233,840 00

INVENTORY OF PERSONAL PROPERTY.

Botanical department,	$9,834 32
Farm,	16,464 50
Laboratory,	1,139 77
Natural history collection,	3,267 04
Library,	9,500 00
Fire apparatus,	500 00
Physics,	3,587 26
Boarding-house,	400 00
	$44,692 89

SUMMARY STATEMENT.

Assets.

Total value of real estate, per inventory,	$233,840 00	
Total value personal property, per inventory,	44,692 89	
Total cash on hand and bills receivable, per inventory,	6,803 49	
Total,		$285,336 38

Liabilities.

Bills payable as per inventory,	5,630 92
	$279,705 46

FUNDS FOR MAINTENANCE OF COLLEGE.

Technical Educational Fund, United States Grant, amount of,	$219,000 00	
Technical Educational Fund, State Grant,	141,575 35	
By law two-thirds of the income is paid to the treasurer of the college, one-third to Institute of Technology. Amount received, 1891,		$11,281 96
State Scholarship Fund, $10,000.00. This sum was appropriated by the Legislature, 1886, and is paid in quarterly payments to the college treasurer,		10,000 00
Hills Fund of $10,000 in hands of college treasurer. This was given by L. M. and H. F. Hills of Amherst. By conditions of the gift the income is to be used for maintenance of a botanic garden. Income, 1891,		601 56
Unexpended balance, Dec. 31, 1891, $17.53.		
Annual State appropriation of $10,000. This sum was appropriated by Legislature of 1889, for four years, for the endowment of additional chairs and general expense. Five thousand dollars of the sum was appropriated as Labor Fund, to provide for the paying of labor performed by needy and worthy students,		10,000 00
Grinnell Prize Fund of $1,000, in hands of college treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of his friend. The income is appropriated for two prizes to be given for the best examination in agriculture by graduating class. Income, 1891,		45 00
Unexpended balance, $20.00		
Mary Robinson Fund of $1,000, in hands of college treasurer, given without conditions. The income has been appropriated to scholarships, to worthy and needy students. Income, 1891,		60 44
Unexpended balance Dec. 31, 1891, $188.18.		
Amount carried forward,		$31,988 96

Amount brought forward, ...	$31,988 96
Whiting Street Fund of $1,000, a bequest without conditions. To this sum is added $260 by vote of the trustees in January, 1887, it being the interest accrued on the bequest. Amount of Fund Dec. 31, 1891, $1,260. Unexpended balance of income, $163.76. Income, 1891, ...	51 15
Library Fund, for use of library, $7,962.03. Deposited in Amherst Savings Bank.	
Gassett Scholarship Fund; the sum of $1,000 was given by the Hon. Henry Gassett as a scholarship fund. Unexpended balance, Dec. 31, 1891, $1.76. Income, 1891, . .	42 94
Total, ...	$32,083 05

To this sum should be added amount of tuition, room rent, receipts from sales of farm and botanic gardens; amount of same can be learned from statement of treasurer. Tuition and room rent under head of term bill.

This is to certify that I have this day examined the accounts of F. E. Paige, treasurer of the Massachusetts Agricultural College, from Jan. 1, 1890, to Jan. 1, 1892, and find the same correct, properly kept, and vouched for. The balance in treasury, being two thousand nine hundred and eighty-six and $\frac{99}{100}$ dollars ($2,986.99), is shown to be in bank.

C. A. Gleason, *Auditor.*

Jan. 8, 1892.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 10, 1891.

To Prof. Chas. H. Fernald, Acting President.

SIR: — I have the honor to submit the following report in regard to matters pertaining to the military department.

INSTRUCTION.

Practical instruction in infantry, artillery, and sabre drill has been given to all the students not excused on account of physical disability. Target practice at 200 and 300 yards has been held, when the weather was suitable, with fair results. Theoretical instruction has been given to the senior, sophomore, and freshman classes, both by lectures and from text-books, according to the schedule.

When the new drill regulations are introduced, the time allowed the military department should be increased so that all the students can study them at the same time.

UNIFORM.

Some trouble is caused on the entrance of each class by the failure of a few students to pay promptly for their uniforms. As a remedy for this I recommend that each student, when he is admitted to college, be required to deposit with the treasurer, the sum of sixteen dollars to cover this necessary expense. After he has received his uniform, the amount not required to pay for it, can be returned to him.

BUILDINGS.

All the rooms in North College are now in good condition. The walls and ceilings of the rooms in South College are in very bad repair. The outside of the drill hall should be painted as soon as possible. I strongly recommend that a new floor be laid and a gallery be built in the drill hall. Concrete, of which the floor is at present constructed, is the worst material that could be used for such a purpose. Many guns have been injured on account of it; it is impossible to prevent the dust from arising from it, while the cadets are drilling, in such quantities as to cause much inconvenience; and during the winter, the floor is always cold, making the drill very uncomfortable. A new floor of hard pine should be laid at once, for

use during the winter term, the best material being used in its construction.

The cost of putting down such a floor will be $525. A gallery also is a much needed improvement. At present, visitors have to stand on the floor, incommoding themselves and interfering with the drill, as there is no room to spare for their accommodation. A gallery of the required dimensions to seat one hundred persons can be constructed at a cost of about $100.

In regard to the method of lighting the college buildings I can only repeat my recommendations of the two previous years. The needs of the college grow more and more urgent every year. The best method of supplying this need is by the introduction of electricity. At present the danger from fire is very great and will continue as long as kerosene is used in such quantities and in the present manner.

BATTALION ORGANIZATION.

Commandant of Cadets:—LESTER W. CORNISH, First Lieut. Fifth United States Cavalry.

Field and Staff:—Major, E. T. CLARK; Adjutant, H. E. CRANE; Quartermaster, R. H. SMITH; Fire Marshal, C. S. GRAHAM; Sergeant Major, F. H. HENDERSON; Quartermaster Sergeant, F. S. HOYT.

Color Guard. — Color Sergeant, C. A. SMITH; Color Corporals, H. J. HARLOW, H. F. STAPLES, and H. C. DAVIS.

Band. — First Sergeant, E. H. LEHNERT; Drum Major, P. E. DAVIS.

Company A.
Capt., G. B. WILLARD.
First Lieut., G. E. TAYLOR.
Second Lieut., J. E. DEUEL.
First Sergt., A. E. MELENDY.
Second Sergt., G. F. CURLEY.
Corporal, F. A. SMITH.

Company B.
Capt., W. I BOYNTON.
First Lieut., F. G. STOCKBRIDGE.
Second Lieut., C. M. HUBBARD.
First Sergt., L. W. SMITH.
Second Sergt., F. G. BARTLETT,
Corporal, E. J. WALKER.

Company C.
Capt., E. ROGERS.
First Lieut., E. B. HOLLAND.
Second Lieut., R. P. LYMAN.
First Sergt., H. D. CLARK.
Second Sergt , C. A. GOODRICH.
Corporal, J. BAKER.

Company D.
Capt., H. B. EMERSON.
First Lieut., J. L. FIELD.
Second Lieut., H. M. THOMSON.
First Sergt., J. R. PERRY.
Second Sergt , J. E. BARDIN.
Corporal, E. A. HAWKS.

Military Prize. — W. H. BOWKER, Class of '71, and JOHN C. CUTTER, Class of '72, have again offered a prize of $15.00 for the best military essay by a member of the graduating class.

Respectfully submitted,

LESTER W. CORNISH,
First Lieutenant Fifth United States Cavalry,
Professor of Military Science and Tactics.

DEPARTMENT OF MENTAL AND POLITICAL SCIENCE.

Prof. Chas. H. Fernald, *Acting President.*

Sir: — I present herewith the following report: —

To the department of Mental and Political Science have been assigned mental science, political economy, constitutional history, rhetoric, the compositions of the junior class during the fall term, the essays, debates and theses of the senior class, and the Chaplaincy of the College.

Mental Science has for its object of study the mind itself, and the brain considered as the instrument of thought. The purpose has been steadfastly adhered to, of making the student familiar with the working of his own brain and acquainted with his own faculties of mind and powers of thought, to the end that he may train himself to think clearly, persistently, forcibly, to useful and practical ends. The phenomena of mind are pointed out that they may be carefully observed, precisely defined, classified properly, and rationally interpreted. The conditions and laws of thought are clearly set forth, so that the student, by fulfiling the conditions and obeying the laws, may discover his own mental weaknesses and remedy them, thereby training his senses to do better work, making his perceptions quicker and clearer, his memory stronger and more trustworthy, his imagination more creative, his powers of generalization, of interpretation, of deductive and inductive reasoning more energetic and sure of reaching independent and truthful results. Especial care is taken to train the mind to collect data, to discriminate essentials from unessentials, to discover the law in phenomena, and from known laws to derive wider applications to particular cases and new problems. These ends are made prominent that the agriculturist, or mechanic, may make his manual labor and many experiments profitable by knowing how to put thought into his work and to recognize the value of a new idea when he finds it.

The study of mental science is pursued the first term of the senior year and so prepares the way for the course in Political Economy which follows in the winter term. Care is taken to make plain the

elements of the science of American economics and to give the student such a knowledge of the essential data and of the accepted principles and methods of investigation and reasoning as shall enable him to understand the living questions of the day, to comprehend current discussions, and to arrive at conclusions which shall commend themselves to his own best judgment and be such as he shall be able to defend against attack. Especial pains are taken to show how the farmer, who has produced crops of the best quality, at the lowest cost, may exchange them to the best advantage and thus increase his own wealth while benefiting all classes of society.

Constitutional History is taught the last term of the senior year, after the class has had the preparatory training in Mental Science and Political Economy. Beginning with the town, the student goes on to consider the city, the county, the State and the federal government. American political institutions are carefully examined, as they are set forth in constitutional and statute law and as they are embodied in the customs and habits of the people and of the parties. The excellencies and evils of our institutions are disclosed and remedies suggested and discussed. The history of our government is studied and the origin and evolution of present institutions are shown. In all the work the end kept prominently before the mind is the practical one of fitting the young man for the duties of the citizen.

The instruction in Rhetoric has been adapted to the varying necessities of different classes. The aim has been to teach the man to think clearly, forcibly and with discernment and good taste, and so let the clear, forcible and beautiful thought compel clearness, force and beauty in the style. While principles and rules have been taught, the necessity of practice has been insisted upon. Daily exercises in writing have been required from each student, together with more formal essays. Topics have been assigned, which have compelled the writers to search far and wide for material; investigating things, consulting libraries, questioning men.

In directing the essays of both classes, the idea of coöperation has been kept prominently in view. Each man is required to do his best, to do original work in the investigation of the topic assigned him, and then to give the class, in the best form possible, the results of his labor, stimulated all the while by the assurance that he shall have the valuable results of the labors of all the other members of the class. In this way, during the last two years of his college course, the student is afforded a view of American and English men of letters and statesmen, and participates in a serious discussion of the practical and social questions of the day in the field of morals, economics, education and political life.

In the accomplishment of these several ends of the department, no one method has been exclusively used, but any and every method that has proved itself best adapted to the varying necessities of different classes and to the requirements of the several individuals of each class. The student has never been sacrificed to the subject taught, but the endeavor has always been made to so present the science that it may be most thoroughly mastered by the pupil, in the shortest possible time, with the greatest ease and interest attainable under the circumstances. Text books and lectures, formal and informal, have been used. In the discussion of economic and political questions the constant aim of the lecturer has been simply to help the student to do his own thinking and to come to his own conclusions after a fair and full consideration of the facts and principles from the best points of view within reach.

A very important duty has devolved upon the Professor of Mental and Political Science, requiring no small amount of time and strength. This is conducting morning prayers and the service on Sunday in the Stone Chapel. Guided strictly by the principles enjoined upon him by constitutional and statute law,* he has endeavored to avoid all sectarianism and to make all his ministrations tend to develop in his hearers the highest type of Christian manhood.

Respectfully submitted,

C. S. WALKER.

* See Constitution of Massachusetts, chapter V., section II., and Statutes, chapter 44, section 15.

CALENDAR FOR 1892-93.

1892.

January 5, Tuesday, winter term begins, at 8.15 A.M.

March 24, Thursday, winter term closes, at 10.30 A.M.

April 5, Tuesday, spring term begins, at 8.15 A.M.

June 19, Sunday.
- Baccalaureate Sermon.
- Address before the Young Men's Christian Union.

June 20, Monday.
- Prize Speaking.
- Grinnell Prize Examination of the Senior Class in Agriculture.

June 21, Tuesday.
- Meeting of the Alumni.
- Military Exercises.
- President's Reception.

June 22, Wednesday.
- Commencement Exercises.
- Meeting of Trustees.

June 23, Thursday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 8 Somerset street, Boston; and at the Sedgwick Institute, Great Barrington.

September 6, Tuesday, examinations for admission, at 9 A.M., Botanic Museum.

September 7, Wednesday, fall term begins, at 8.15 A.M.

December 23, Friday, fall term closes, at 10.30 A.M.

1893.

January 3, Tuesday, winter term begins, at 8.15. A.M.

March 23, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires
THOMAS P. ROOT of Barre Plains,	1893
J. HOWE DEMOND of Northampton,	1893
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899

Members Ex-Officio.

His Excellency Governor WILLIAM E. RUSSELL, *President of the Corporation.*
HENRY H. GOODELL, *President of the College.*
JOHN W. DICKINSON, *Secretary of the Board of Education.*
WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer, pro tem.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

THOMAS P. ROOT. FRANCIS H. APPLETON.
WILLIAM H. BOWKER. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
JOSEPH A. HARWOOD. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

W. A. KILBOURN, . . . of South Lancaster.
A. C. VARNUM, ... of Lowell.
GEORGE CRUICKSHANKS, . . of Fitchburg.
P. M. HARWOOD, ... of Barre.
DR. WILLIAM HOLBROOK, . . of Palmer.
C. A. MILLS, ... of South Williamstown.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages and English Literature.

* The President of the college is ex-officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B. Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B. Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph. D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph. D.,
Professor of Zoology.

Rev. CHARLES S. WALKER, Ph. D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B. Sc.,
Professor of Agriculture.

LESTER W. CORNISH, 1st Lieut. 5th Cavalry, U. S. A.,
Professor of Military Science and Tactics.

GEORGE F. MILLS, M. A.,
Professor of English.

JAMES B. PAIGE, V. S.,
Professor of Veterinary Science.

ROBERT W. LYMAN,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

FRED S. COOLEY, B. Sc.,
Farm Superintendent.

Graduates of 1891.*

Arnold, Frank Luman (Boston Univ.),	Belchertown.
Brown, Walter Augustus (Boston Univ.),	Feeding Hills.
Carpenter, Malcolm Austin (Boston Univ.),	Leyden.
Eames, Aldice Gould (Boston Univ.),	North Wilmington.
Felt, Ephraim Porter (Boston Univ.),	Northborough.
Field, Henry John (Boston Univ.),	Leverett.
Gay, Willard Weston (Boston Univ.),	Georgetown.
Horner, Louis Frederic (Boston Univ.),	Newton Highlands.
Howard, Henry Merton (Boston Univ.),	Franklin.
Hull, Jr., John Byron (Boston Univ.),	Stockbridge.
Johnson, Charles Henry (Boston Univ.),	Prescott.
Lage, Oscar Vidal Barboza (Boston Univ.),	Juiz de Fora, Minas-Geraes, Brazil.
Legate, Howard Newton (Boston Univ.),	Sunderland.
Magill, Claude Albion (Boston Univ.),	Amherst.
Paige, Walter Cary, (Boston Univ.),	Amherst.
Ruggles, Murray (Boston Univ.),	Milton.
Sawyer, Arthur Henry (Boston Univ.),	Sterling.
Shores, Harvey Towle (Boston Univ.),	West Bridgewater.
Total,	18.

Senior Class.

Beals, Alfred Tennyson,	Greenfield.
Boynton, Walter Ira,	North Amherst.
Clark, Edward Thornton,	Granby.
Crane, Henry Everett,	Weymouth.
Deuel, James Edward,	Amherst.
Emerson, Henry Bennett,	Gloucester.
Field, Judson Leon,	Leverett.
Fletcher, William,	Chelmsford.
Graham, Charles Sumner,	Holden.
Holland, Edward Bertram,	Amherst.
Hubbard, Cyrus Moses,	Sunderland.
Knight, Jewell Bennett,	Belchertown.
Lyman, Richard Pope,	Boston.
Plumb, Frank Herbert,	Westfield.
Rogers, Elliot,	Allston.
Smith, Robert Hyde,	Amherst.
Stockbridge, Francis Granger,	Northfield.
Taylor, George Everett,	Shelburne.
Thomson, Henry Martin,	Monterey.
West, Homer Cady,	Belchertown.
Willard, George Bartlett,	Waltham.
Williams, Milton Hubbard,	Sunderland.
Total,	22.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1891.

Junior Class.

Baker, Joseph,	Dudley.
Bardin, James Edgar,	Dalton.
Bartlett, Fred Goff,	Hadley.
Clark, Henry Disbrow,	Plainfield.
Curley, George Frederick,	Upton.
Davis, Herbert Chester,	Amherst.
Goodrich, Charles Augustus,	Hartford, Conn.
Harlow, Francis Turner,	Marshfield.
Harlow, Harry James,	Shrewsbury.
Hawks, Ernest Alfred,	Williamsburg.
Henderson, Frank Howard,	Lynn.
Howard, Edwin Carleton,	Wilbraham.
Hoyt, Franklin Sherman,	Newtown, Conn.
Kellogg, John Hawkes,	Hartford, Conn.
Lehnert, Eugene Hugo,	Clinton.
Melendy, Alphonso Edward,	Sterling.
Pember, Walter Stephen,	Walpole.
Perry, John Richards,	Boston.
Ranney, William Henry,	South Ashfield.
Sedgwick, Benjamin,	Cornwall Hollow, Conn.
Smith, Cotton Atwood,	North Hadley.
Smith, Fred Andrew,	Lynn.
Smith, Luther Williams,	Ashfield.
Staples, Henry Franklin,	Leominster.
Tinoco, Luiz Antonio Ferreira,	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph,	West Berlin.
Total,	26.

Sophomore Class.

Alderman, Edwin Hammond,	Middlefield.
Austin, John,	Belchertown.
Averell, Fred Gilbert,	Amherst.
Bacon, Linus Hersey,	Spencer.
Bacon, Theodore Spalding,	Natick.
Barker, Louis Morton,	Hanson.
Barton, Charles Henry,	Dalton.
Boardman, Edwin Loring,	Sheffield.
Brown, Charles Leverett,	Feeding Hills.
Cook, Jay Erastus,	Hadley.
Curtis, Arthur Clement,	Littleton Common.
Cutter, Arthur Hardy,	Pelham, N. H.
Davis, Perley Elijah,	Worcester.
Dickinson, Eliot Taylor,	Amherst.
Duffield, William Charles,	Quincy Point.
Fowler, Halley Melville,	South Gardner.
Fowler, Henry Justin,	North Hadley.
Gifford, John Edwin,	Brockton.

Goessmann, Louis Edward,	Amherst.
Goodell, John Stanton,	Amherst.
Greene, Frederic Lowell,	Shrewsbury.
Greene, Ira Charles,	Fitchburg.
Higgins, Charles Herbert,	Dover.
Howard, Samuel Francis,	Wilbraham.
Johnson, Charles Frederic,	Littleton.
Jones, John Horace,	Pelham.
Keith, Thaddeus Fayette,	Fitchburg.
Kirkland, Archie Howard,	Norwich.
Lewis, Henry Waldo,	Rockland.
Lounsbury, Charles Pugsley,	Allston.
Manley, Lowell,	Brockton.
Mann, Henry Judson,	Maplewood.
Marvin, Samuel Barnard,	Richford, Vt.
Merwin, George Henry,	Westport, Conn.
Morse, Alvertus Jason,	Belchertown.
Morse, Elisha Wilson,	Brockton.
Park, Fred Ware,	South Chelmsford.
Parker, Frank Ingram,	Pittsfield.
Parker, Jacob,	Plymouth.
Pomeroy, Robert Ferdinand,	South Worthington.
Putnam, Joseph Harry,	West Sutton.
Robbins, Dana Watkins,	Walpole.
Sanderson, William Edwin,	Hingham.
Sanford, George Otis,	Winchendon.
Shepard, Lucius Jerry,	Oakdale.
Smead, Horace Preston,	Greenfield.
Smith, George Eli,	Sheffield.
Smith, Ralph Eliot,	Newton Centre.
Spaulding, Charles Harrington,	East Lexington.
Stockwell, Harry Griggs,	Sutton.
Streeter, Albert Richmond,	Cummington.
Sullivan, Maurice John,	Amherst.
Toole, Stephen Peter,	Amherst.
Walker, Claude Frederic,	Amherst.
White, Elias Dewey,	South Sherborn.
Total,	55.

Freshman Class.

Bagg, Edward Oren,	West Springfield.
Ballou, Henry Arthur,	West Fitchburg.
Bemis, Waldo Louis,	Spencer.
Billings, George Austin,	South Deerfield.
Brown, Mendall Howard,	Amherst.
Brown, William Clay,	Peabody.
Burgess, Albert Franklin,	Rockland.
Clark, Edile Hale,	Spencer.
Cooley, Robert Allen,	South Deerfield.

Crehore, Charles Winfred,	Chicopee.
Davis, Alfred,	West Roxbury.
Dickinson, Charles Morrison,	Park Ridge, Ill.
Drury, Ralph Willard,	Athol Centre.
Dwyer, Elmer Francis,	Lynn.
Fairbanks, Herbert Stockwell,	Amherst.
Foley, Thomas Patrick,	Natick.
Frost, Harold Locke,	Arlington.
Haskell, Ernest Albert,	Amherst.
Hemenway, Herbert Daniel,	Williamsville.
Henderson, Edward Harris,	Malden.
Hubbard, Guy Augustus,	Ashby.
Jones, Robert Sharp,	Dover.
Kuroda, Shiro,	Shobara, Japan.
Lane, Clarence Bronson,	Killingworth, Conn.
Marsh, Jasper,	Danvers Centre.
Mason, Amos Hall,	Medfield.
Morse, Walter Levi,	Middleborough.
Potter, Daniel Charles,	Fairhaven.
Read, Henry Blood,	Westford.
Root, Wright Asahel,	Deerfield.
Sastré Verand, Salome,	Had, Esquipulas, Cunduacan, Tabasco, Mexico.
Shaw, Frederic Bridgman,	South Amherst.
Smith, Arthur Bell,	North Hadley.
Stevens, Clarence Lindon,	Sheffield.
Taylor, Effod Earl,	North Amherst.
Tobey, Frederic Clinton,	West Stockbridge.
Volio, Enrique Tinoco,	San José, Costa Rica.
Warren, Frank Lafayette,	Shirley.
Weed, Percy Loring,	Boston.
Wentzell, William Benjamin,	Amherst.
White, Edward Albert,	Fitchburg.
Williams, John Sherman,	Middleborough.
Woodbury, Roger Atwater,	Cheshire, Conn.
Total,	43.

Resident Graduates at the College and Experiment Station.

Arnold, B. Sc., Frank Luman (Boston Univ.),	Belchertown.
Cooley, B. Sc., Fred Smith,	Sunderland.
Court, William Boyce (Mcgill Univ.),	Montreal, Canada.
Crocker, B. Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Field, B. Sc., Henry John (Boston Univ.),	Leverett.
Haskins, B. Sc., Henry Darwin, (Boston Univ.),	North Amherst.
Johnson, B. Sc., Charles Henry (Boston Univ.),	Prescott.

Jones, B. Sc., Charles Howland (Boston Univ.),	Downer's Grove, Ill.
Loring, B. Sc., John Samuel (Boston Univ.),	Shrewsbury.
Moore, B. Sc., Robert Bostwick (Boston Univ.),	Framingham.
Ono, B. Agr., Saburo (Sapporo Agricultural College),	Ono, Echizen, Japan.
Parsons, B. Sc., Wilfred Atherton,	Southampton.
Shepardson, B. Sc., William Martin (Boston Univ.),	Warwick.
Smith, B. Sc., Frederic Jason (Boston Univ.),	North Hadley.
West, B. Sc., John Sherman (Boston Univ.),	Belchertown.
Williams, B. Sc., Frank Oliver (Boston Univ.),	Sunderland.
Woodbury, B. Sc., Herbert Elwell,	Gloucester.
Total,	17.

Summary.

Resident Graduates,	17
Graduates of 1891,	18
Senior class,	22
Junior class,	26
Sophomore class,	55
Freshman class,	43
Total,	181
Counted twice,	3
Total,	178

COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoology and Veterinary Science.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Climatology, or Relations of Weather and Farming,—2.	Botany, Structural, —5.	Chemistry, Principles and Metalloids, —5.	- - -	Algebra,—5.	Latin,—3.	Composition, —1.	3*
Winter, .	Farm Accounts, History of Agriculture,—2.	- - -	Metals,—4.*	- - -	Algebra and Geometry, —5.	Latin,—4.	Free-hand drawing,—6.	Tactics. Half Term,—1.—3.*
Spring, .	Breeds of Live Stock, Hand Tools,—5.	Botany, Analytical, —5.	Mineralogy,—4.*	- - -	Geometry,—3.	Latin,—5.	Composition, —1.	3*

Sophomore Year.

Fall, . .	Soils. Tillage and Drainage,—5.	Botany, Economic, —5.	Geology,—4.*	- - -	Trigonometry, —4.	French,—5.	Composition, —1.	Tactics. Half Term,—1.—3.*
Winter, .	Mixed Farming, Rotation of Crops,—2.	Laboratory Work, —4.*	- - -	Anatomy and Physiology,—5.	Mensuration, —3.	French,—5.	Mechanical Drawing,—5	3*
Spring, .	Manures. Grains and Forage Crops, —5.	Horticulture,—8.	- - -	- - -	Surveying, —7.*	French,—5.	Composition, —1.	3*

Junior Year.

Fall, . .	Farm Implements. Harvesting and Storing Crops, — 2.	Market Gardening, — 6.*	- - -	Zoology. Laboratory work, — 8.	Mechanics, Draft, Friction, etc. — 3.	Rhetoric and Composition, — 5.	- -	3*
Winter, .	Preparation and Transportation of Crops. Markets, — 2.	- - -	Laboratory work, — 10.	Zoology, — 3.	Physics, Sound and Heat, — 4.*	English Literature, — 5.	Composition, — 1.	3*
Spring, .	Special Crops, Farm Roads, — 1.	Forestry and Landscape Gardening. — 6.*	Laboratory work, — 5.	Entomology, — 7.	Physics, Light and Electricity, — 3.	English Literature, — 4.	Composition, — 1.	3*

Senior Year.

Fall, . .	Breeding and Care of Live Stock, — 4.*	Lectures, Law, etc.	Laboratory work, Chemistry of Fertilizers, — 8.	Comp. Anatomy of Domestic Animals, — 3. Veterinary Science, — 5.	- -	Mental Science, — 4.	Composition and Debate, — 1.	Mil. Science, — 1. — 3.*
Winter, .	Dairy Farming, — 3.		Organic, — 3.	Veterinary Science, — 5.	Meteorology, — 2.	Political Economy, — 5.	Composition, and Debate, — 1.	Mil. Science, — 1. — 3.*
Spring, .	Agricultural Review. Discussions, — 3.		Chemical Industries, — 3.	Geology, — 3. Veterinary Science, — 5.	- -	Constitutional History, — 5.	Composition, — 1.	Mil. Science, — 1. — 3.*

* Afternoon exercises.

TEXT BOOKS.

WOOD — "The American Botanist and Florist."
GRAY — "Manual."
LONG — "How to Make the Garden Pay."
LONG — "Ornamental Gardening."
FULLER — "Practical Forestry."
MAYNARD — "Practical Fruit Grower."
MCALPINE — "How to know Grasses by their Leaves."
FISHER — "Classbook of Elementary Chemistry."
ROSCOE — "Lessons in Elementary Chemistry."
ROSCOE AND SCHORLEMMER — "Treatise on Chemistry."
WILLS — "Tables for Qualitative Chemical Analysis."
FRESENIUS — "Qualitative Chemical Analysis."
FRESENIUS — "Quantitative Chemical Analysis."
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Manual of Determinative Mineralogy."
WELLS — "College Algebra."
DANA — "Mechanics."
WENTWORTH — "Plane and Solid Geometry."
CARHART — "Surveying."
WARNER — "Mensuration."
WELLS — "Plane and Spherical Trigonometry."
ATKINSON'S GANOT'S PHYSICS.
LOOMIS — "Meteorology."
PORTER — "The Elements of Intellectual Science."
GENUNG — "The Practical Elements of Rhetoric."
WALKER — "Political Economy," abridged edition.
EMERSON — "Evolution of Expression."
LOCKWOOD — "Lessons in English."
COMSTOCK — "First Latin Book."
CÆSAR — "The Invasion of Britain."
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39 — "Riverside Literature Series."
SPRAGUE — "Six Selections from Irving's Sketch-Book."
HUDSON — "Selections of Prose and Poetry." Webster, Burke, Addison, Goldsmith, Shakespeare.
GENUNG — "Handbook of Rhetorical Analysis."
WHITNEY — "French Grammar."
KELLOGG — "English Literature."
WHITE — "Progressive Art Studies."

To give not only a practical but a liberal education is the aim in each department; and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons

of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded instruction in military tactics is made imperative; and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

ADMISSION.

Candidates for admission to the freshman class are examined, orally and in writing, upon the following subjects: English grammar, geography, arithmetic, algebra, to quadratic equations including radicals, the metric system, and the history of the United States. The standard required is sixty-five per cent. on each paper.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the examining committee with their standing in the schools they have last attended. The previous rank of a candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 23, and on Tuesday, September 6; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at nine o'clock A.M., on Thursday, June 23, at Jacob Sleeper Hall, Boston University, 8 Somerset Street, Boston; and, for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird.

ENTRANCE EXAMINATION PAPERS USED IN 1891.

Metric System.

1. When and where did the Metric System originate?
2. What is the base of the Metric System?
3. Name the principal units and give their equivalents.
4. Write the tables for Long Measure and Liquid Measure.

* Certificates of disability must be procured from Dr. D. B. N. Fish of Amherst.

5. How many ares in a floor 1.25 metres long and 8.7 metres wide?

6. How many metres of a carpet nine decimetres wide will cover a floor six metres long and five and four-tenths metres wide? and what would be the cost of the carpet, at $2.50 a centare?

7. In 2 miles, 6 furlongs, 39 rods, and 5 yards, how many kilometres?

8. What will be the cost of a pile of wood 42.5 metres long, 2 metres high, 1.9 metres wide, at $2 per stere?

9. A grocer buys butter at $0.28 per pound, and sells it at $0.60 per kilogram. Does he gain or lose, and what per cent.?

10. A merchant bought 240 metres of silk at $2, and sold it at $1.95 per yard. Did he gain or lose, and how much?

Grammar and Composition.

1. Define Etymology; Syntax.

2. What is meant by Parts of Speech? Name them.

3. How many cases are there? Which parts of speech have case? Name the regular constructions in which the objective case is used.

4. What is conjugation? Name the modes of the verb. What is tense? Name the tenses of the indicative mode.

5. What is a sentence? How are sentences classified according to *form?* What is a clause? a phase?

6. Parse the words in italics in the following:

Stand! the ground's your own my braves!
Will ye give *it up* to slaves?
Will ye look for *greener* graves?
Hope ye *mercy still?*

7. Construct a complex declarative sentence from words in the above lines.

8. Write correctly the following sentences: (*a*) Tom stared at me and I wished I was home. (*b*) There was a grand baloon ascension which landed at west roxbury. (*c*) Where did you get that book from? You hadn't ought to have it.

9. Write the title of any six books that you have read since Jan. 1, 1889. 10. Write a composition of at least one hundred words on one of the following subjects: (*a*) My purpose in entering the Massachusetts Agricultural College. (*b*) The Life of a Farmer. (*c*) Base-ball.

Arithmetic.

1. What is a prime number? a composite number? Give examples of each.

2. Find the least common multiple of 30, 32, 36, 40, 48.

3. Write down in the order of their magnitude $\frac{5}{12}$, $\frac{7}{18}$, $\frac{11}{25}$, $\frac{13}{30}$.

4. Divide $3\frac{1}{5}$ of $11\frac{1}{4}+7\frac{1}{9}$ by $\frac{8}{33}$ of $7\frac{1}{3}$.

5. Define Proportion and solve the following problem: If a man walk 96 miles in 5 days, walking 6 hours a day, in how many days will he walk 480 miles, walking 5 hours a day.

6. Define Simple and Compound interest. Find the interest on $2,438.80 from January 3 to May 26 at four per cent. per annum.

7. Goods which cost $35 are sold for $42: find the profit per cent.

8. Find the cube root of 2,222. 447,625.

9. What is the difference between Bank Discount and true Discount? Find the Present Value of a bill for $907.20 due two years hence at four per cent.

10. How much will a load of wood 12 feet long, $4\frac{1}{2}$ feet wide, and 42 inches high cost at $8 per cord?

Algebra.

1. What is an algebraic expression?

2. Define coefficient, exponent, trinomial, and give the law of signs in Multiplication and Division.

3. Divide $x^3+8y^3-125z^3+30xyz$ by $x+2y-5z$.

4. Reduce to its lowest terms:

$$\frac{x^2-8x+5}{2x^2-13x+21} \quad \text{and} \quad \frac{x^2-x-20}{2x^2-7x-15}$$

5. Solve: $\dfrac{2x+1}{2x-1}-\dfrac{8}{4x^2-1}=\dfrac{2x-1}{2x+1}$

6. Solve: $3x-2y=28.$
$2x+5y=63.$

7. Find the cube root of:

$$x^6+1-6x-6x^5+15x^2+15x^4-20x^3.$$

8. Divide $x-3x^{\frac{5}{6}}-3x^{\frac{2}{3}}+1$ by $-x^{\frac{1}{3}}-1$.

9. Find the square root of $75+12\sqrt{21}$.

10. Solve $\sqrt{32+x}=16-\sqrt{x}$.

Geography.

1. Describe the processes by which the water of the sea returns to the sources of the rivers.

2. Account for the difference of temperature, in our latitude, in January and July.

3. Name five prominent peninsulas of North America.

4. Name the States in which these lakes are located: Moosehead, Okeechobee, Winnepesaukee, Pontchartrain, Itasca.

5. Draw an outline map of Massachusetts, and locate upon it the following: (*a*) Cities and towns, — Boston, Lowell, Springfield, Amherst, Plymouth. (*b*) Rivers, — Merrimac, Charles, Connecticut. (*c*) Mountains, — Holyoke, Wachusett, Greylock.

6. Bound South Dakota. Describe the shortest water route from New York to San Francisco.

7. In which State and on what river is each of these cities located: Memphis? Rochester? Richmond? Vicksburg? St. Paul? Bangor?

8. On what waters would one sail in making a voyage from Liverpool to Venice?

9. In what country and on or near what water are the following: Amsterdam? Lisbon? Naples? Antwerp? Calcutta? Sydney? Tokio? Odessa? Marseilles? Hamburg?

10. Name any six political divisions of Asia.

United States History.

1. When, where, and by whom was the first permanent settlement made in our country? What permanent settlements were made by the English? by the French?

2. What three kinds of colonial governments were there? Outline each, and name the colonies that were under each. When did the colonies become States? When did the nation begin?

3. In what year and where did the first Continental Congress meet? What important resolution did it adopt? In what year and where did the second Continental Congress meet? What important State paper did it issue? How long did this Congress continue its sessions?

4. Name three patriot generals and three British generals of the Revolutionary War. Write a short account of any battle fought in Massachusetts during the Revolutionary War.

5. How did African slavery originate in the United States, and how was it abolished?

6. Name five citizens of Massachusetts who rendered distinguished services to the government in the Civil War.

7. Name the State or States in which occurred any battle or battles during the Civil War?

8. What States have been admitted to the Union since the close of the Civil War.

9. Name the presidents who have held office for two terms. In which Congressional district do you reside, and who is the Representative in Congress from your district?

10. What is the latest purchase of territory by the United States? Of whom was this purchase made?

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

EXPENSES.

Tuition, in advance: —

Fall term,	$ 30 00		
Winter term,	25 00		
Summer term,	25 00	$ 80 00	$ 80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been two dollars and forty-five cents per week; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used, and also a charge of four dollars per term for the expenses of the zoölogical laboratory. Some expense will also be incurred for lights and for text books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Professors Wm. P.

Brooks and Samuel T. Maynard respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and one-half by fourteen feet and one-half, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Appli-

cants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College : —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established : —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Botanical Department.

Botanic Museum. — This contains the Knowlton Herbarium, consisting of over ten thousand species of flowering plants and vascular cryptogams, to which have been added the past season several collections of mosses, lichens and fungi; a collection of models of nearly all of the leading varieties of apples and pears; a large col-

lection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems; fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by its expansive force the enormous weight of five thousand pounds.

The botanic lecture room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The botanical laboratory adjoining the lecture room has been enlarged and improved, and is equipped with compound and dissecting microscopes and other apparatus, so that each student is enabled to dissect and study all the parts of the plant, and gain a knowledge of its structure that he can get in no other way. In this work and in general structural botany the common and useful plants are used for study.

Conservatories. — The Durfee Conservatory, the gift of the Hon. Nathan Durfee, contains a large collection of plants especially adapted to illustrate the principles of structural, systematic and economic botany, together with all the leading plants used for house culture, cut flowers and out door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc., by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and students, who may watch the progress of growths and methods of cultivation.

Two new propagating houses heated with hot water, one with the piping above the benches and the other with the piping below them, combine many illustrations in the way of methods of building, which, together with other green-houses, afford an abundant opportunity for the study of green-house building and heating.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., are taught by field exercises, the students doing a large part of the work in this department.

Nursery. — This contains many thousand trees, shrubs and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning and training of young trees are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery; and plantations have been made upon the college grounds and upon private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Zoölogical Department.

Zoölogical Lecture Room. — This room, in south college, is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons, and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders, and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris. The museum is now open to the public from 3 to 4 P.M. every day except Saturday and Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there is an Eckhold's omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydro-dynamics and pneumatics. For physics the apparatus is amply sufficient for illustrating the general principles of sound, heat, light and electricity. Adjacent to the commodious lecture room are a battery room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects the department is equipped as follows :—

For general chemistry the lecture room contains a series of thirty wall charts illustrative of chemical processes on the large scale ; a series of seven wall charts, showing the composition of food materials ; and a collection of apparatus, for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops, and the manufacture of fertilizers ; a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents (wet and dry), a fume chamber, water, gas, drawer and locker, the whole arranged on an improved plan ; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy use is made of the larger

chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy, serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers ten thousand five hundred and ninety volumes, having been increased during the year, by gift and purchase, five hundred and ninety volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Fred. H. Fowler of the class of 1887. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

A prize of fifteen dollars for the best essay on some military subject is offered this year to the graduating class by William H. Bowker, '71, and John C. Cutter, '72.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1892, fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and

a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1891 were awarded as follows:

Kendall Rhetorical Prizes. — John R. Perry [1893], 1st.; Luther W. Smith [1893], 2d.; Frank I. Parker [1894], 1st.; Arthur C. Curtis [1894], 2d.

Grinnell Agricultural Prizes. — Malcom A. Carpenter [1891], 1st.; Henry M. Howard [1891], 2nd.

Hills Botanical Prizes. — Walter A. Brown [1891], 1st; Louis F. Horner [1891], 2d; Collection of native woods — Ephraim P. Felt [1891].

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M. and public worship in the chapel every Sunday at 10.30 A.M. unless, by request of their parents, arrangements are made to attend divine services elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

MILITARY INSTRUCTION IN EDUCATIONAL INSTITUTIONS.

Lieut. Lester W. Cornish.

The fact that military instruction is given by officers of the regular army in various educational institutions throughout the United States may be generally known, yet the extent to which this instruction is carried on, and the benefits to be derived from it by the government, by the individual States, and by the students themselves, have been little considered.

Many parents, failing to see the benefit to be derived from this instruction, think that their sons' time while at college might be more profitably spent, and therefore object to having them take the military course. A little consideration will change this idea, and a short account of what is being done may be of general interest.

On July 2, 1862, Congress passed an act giving to such States as would accept the conditions, public lands to the amount of 30,000 acres for each senator and representative to which the State was entitled at that time. The money obtained from the sale of these lands was to form a permanent fund, the interest of which was to be, in the language of the bill, "inviolably appropriated by each State which may take and claim the benefit of this act, to the endowment, support and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts."

In order to increase the benefits to the colleges organized under this act, as well as to insure some practical return to the government for its aid, another bill was approved on July 28, 1866, which read as follows: "That for the purpose of promoting knowledge of military science among the young men of the United States, the President may, upon the application of an established college or university within the limits of the United States, with sufficient capacity to educate at one time not less than one hundred and fifty male students, detail an officer of the army to act as president, superintendent, or professor of such college or university; that the number of officers

so detailed shall not exceed twenty at any time, and shall be apportioned throughout the United States as nearly as practicable according to population, and shall be governed by the general rules to be prescribed from time to time by the President."

As the experiment of detailing officers of the army for this purpose proved a success, the number was increased, until at the present time seventy-five may by law be detailed on college duty. The issue of the necessary ordnance and ordnance stores by the Secretary of War having been authorized, the following articles can be obtained by each of these colleges, bonds being given for twice their value, viz: two light field guns with all their equipments, and one cadet rifle and set of infantry accoutrements for each cadet that drills. In addition to these arms, the following allowance of ammunition for practice firing is made annually to each of the various institutions, viz.: one hundred blank cartridges and three hundred friction primers for field guns, and for each cadet actually engaged in target practice fifty rifle ball cartridges.

The following rules have been prescribed by the President, for the government of officers of the army detailed as professors of military science and tactics:—

Duties of Officers.

The professor of military science and tactics shall reside at or near the institution to which assigned, and when in the performance of his military duties shall appear in proper uniform. Officers so detailed shall, in their relations to the institutions, observe the general usages and regulations therein established affecting the duties and obligations of other members of the faculty. For the benefit of the officer and the military service, he may perform other duties at the college in addition to those pertaining to military science and tactics, and may receive such compensation therefor as may be agreed upon.

Organization and Discipline.

1. All rules and orders relating to the organization and government of the military students, — the appointment, promotion, and change of officers, and all other orders affecting the military department, except those relating to routine duty, — shall be made and promulgated by the professor of military science and tactics, after being approved by the president or other administrative officer of the institution.

2. It is the duty of the professor of military science and tactics to enforce proper military discipline at all times when students are under military instruction, and, in case of serious breaches of discipline, or misconduct, to report the same to the proper officers of the institution, according to its established methods. Upon occasions of military ceremony, in the execution of drills, guard duty, and when students are receiving any other practical military instruction, he shall see that they appear in the uniform prescribed by the institution.

Course of Instruction.

1. The course of instruction shall be both practical and theoretical, and shall be so arranged as to occupy at least one hour per week for theoretical instruction, and at least two hours per week for practical instruction.

2. The practical course in infantry shall embrace small arm target practice and, as far as possible, all the movements prescribed by the drill regulations of the United States Army applicable to a battalion. Instruction in artillery shall embrace, as far as practicable, such portions of the United States drill regulations as pertain to the formations of detachments, manual of the piece, mechanical manœuvres, aiming drill, sabre exercise and target practice. Instruction should also include the duty of sentinels and, where practicable, castrametation. Such instruction shall be given by the professor of military science and tactics personally, or under his immediate supervision.

3 Theoretical instruction shall be by recitations and lectures, personally conducted and given by the professor of military science and tactics, and shall include, as far as practicable, a systematic and progressive course in the following subjects: the drill regulations of the United States Army, the preparation of the usual reports and returns pertaining to a company, the organization and administration of the United States Army, and the elementary principles governing in the art of war.

Reports.

He shall render a quarterly report to the adjutant-general of the army of the whole number of undergraduate students in the institution capable of performing military duty, the number required by the institution to be enrolled as military students, the average attendance at drills, the number absent, the number and kind of drills, recitations and lectures, or other instruction had during the quarter, and the number reported for discipline. On the graduation of every class he shall obtain from the president of the college, and report to the adjutant-general of the army, the names of such students as have shown special aptitude for military service, and furnish a copy thereof to the adjutant-general of the State for his information. The names of the three most distinguished students in military science and tactics at each college shall, when graduated, be inserted on the United States Army Register and published in general orders.

There are seventy-three officers of the army at the present time on college duty, and the valuable results of their work to the national government, to the States, and to the students themselves, have been but little considered by the majority of the people.

At the beginning of the great civil war, there were but few schools or colleges at the North where military instruction was incorporated into the curriculum. In the South, on the contrary, there were many such institutions, and in them young men learned the art of controlling others, as well as that of handling firearms and moving troops. As a consequence of this, the Confederate army was much better

officered than the Union army at the beginning of the great national struggle.

The officers of the volunteer troops from the North labored under the greatest difficulty. They had to learn before they could teach others, and while, in time, some of these same officers astonished the world by their military genius and ability, the cost to the country at which this ability was obtained was almost incalculable.

General Scott claimed that the shortness of the Mexican war was due to the military knowledge of, and the efficient work done by, the young officers who were graduates of the United States Military Academy, and the civil war would have been of much shorter duration, and thousands of valuable lives saved, if the supply of men, sufficiently instructed in the military profession to fill the places of subordinate officers, had been equal to the demand.

That such a want might not be felt in the future, if this country should again be obliged to suffer the horrors of a great war, was the idea of those great statesmen who drafted what was known as the "Land Grant College Act." Senator Morrill of Vermont, to whose untiring energy in supporting it, was due, to a great degree, its final success, says: "In case of war all the students of these colleges would be of great value to the nation. Each one would be able to take a body of raw recruits and speedily drill them so as to be ready for service, and it will be, in time, an immense reserve force."

Let us consider what is now being done in this direction. The seventy-three educational institutions at which officers of the army are now on college duty, are distributed over the United States as follows: Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Mississippi, Nebraska, Nevada, New Jersey, North Carolina, North Dakota, Oregon, Tennessee, Utah, West Virginia, Wisconsin and Wyoming, each have one; Alabama, Maryland, Michigan, Minnesota, North Dakota, Texas and Virginia have two; Illinois, Indiana, Iowa, Missouri, South Carolina and Vermont have three; Ohio and Pennsylvania have four; while New York has eight. The report of the adjutant-general of the United States Army for 1891 gives a consolidated report from fifty-seven of these colleges from which I have taken the following figures:

The number of students over fifteen years of age attending these institutions was fifteen thousand seven hundred and seventeen. Of this number, twelve thousand three hundred and one constitute the whole number of male students capable of performing military duty, while seven thousand four hundred and eighty-seven represent the number attending those institutions where military instruction is compulsory. The total number that received military instruction during

the last quarter of the scholastic year was seven thousand three hundred and sixty-six.

At quite a number of the institutions from which these figures were obtained, the military course is optional, since these colleges do not receive the benefit of the land grant act. The fact that these colleges have voluntarily inserted a military department, and applied to the Secretary of War for the detail of an officer of the army, shows the value that prominent educators attach to this military education. From personal correspondence with all the officers on college duty, I have heard of but one case where the interest shown by the faculty was even indifferent. All the rest consider the military department to be a very valuable one, both to the students and to the college. The majority of the students are interested in the military work, both theoretical and practical.

The charge has been made, and with some degree of truth, that the Americans are, as a rule, devoted to money-getting, and that they have little pride in their country's name and place abroad. By means of this military instruction, a closer relationship will be established between the young men and their country, the reputation and authority of which must be maintained both at home and abroad. A stronger feeling of patriotism will be inculcated, and a greater love for their country's good name be implanted in the hearts of the young men of this cosmopolitan nation. Our country is large and populous; but fortunately for us, we are not surrounded by other nations who are continually endeavoring to obtain some portion of our territory.

We have no need of such immense standing armies as European nations are obliged to support, and in the support of which they are being brought to the verge of bankruptcy. While our regular army is small, numbering only twenty-five thousand, it has proved itself to be sufficiently large to protect our western frontier, and preserve order when called upon to do so; but it could only be used as a nucleus for the large army we should need, in order to repel an invasion by any of the foreign powers. Our main reliance must be on volunteer troops, which, to be rendered effective in the short time that would be available, must be officered by men capable of giving good instruction. Under our present system of military instruction, men can be found in almost every village competent to enlist a company, drill it properly, and in a short time fit it to be joined with others, formed in the same way, to make effective regiments. The old saying, "In time of peace prepare for war," is one which it will be well for the American people to keep in mind.

The individual States depend on their militia to preserve the public peace, and insure to every inhabitant, the freedom to exercise all his

rights as a citizen. These troops are made more effective by means of this military instruction. The best officers are graduates of institutions where they have had military instruction, and they serve to raise the standard of the whole body. This is the testimony of nearly all the adjutant-generals of the different States. The United States Corps of Cadets at the United States Military Academy forms a separate and distinct part of the United States Army, liable to be called upon for active service in case of necessity, the graduates being required to serve the government for four years longer if their services are desired. Why could not this same plan be most profitably instituted in the various States? The majority of the students are from the States where the various colleges are located, and are aided by the State in obtaining their education. Some service might well be asked in return for this aid. Let the students in the various institutions be organized into separate battalions of the National Guard, and uniformed by the State, — for many of the students are poor, and expense of the uniform prevents them from taking the military drill when it is not compulsory. Where this is done, require after graduation a given amount of service, perhaps not more than two years, in the National Guard of the State, giving to such as are recommended by the military instructor, commissions as brevet or additional second lieutenants, and assign them to duty with the militia companies nearest their respective homes. This plan would give the students, after graduation, an insight into the practical working of our militia system, and be of much benefit to the State in furnishing it with officers having both a technical and practical knowledge of military work.

Having held commissions as cadets, many students object to enlisting as privates in the militia after graduation, but if they could obtain commissions they would gladly serve the State to the best of their ability, and remain in the service longer than the required length of time. The chance of obtaining a commission after graduation would be an incentive to better work in the line of military study, and proportionately better results would be obtained. The extra expense to the State would, in my judgment, be amply repaid. In several of the States these commissions are now being given with good results.

The increased efficiency of the militia is not the only benefit that the State derives from the military education of its young men. The necessary subordination to military discipline makes of them a law-respecting and a law-abiding body of citizens, and the advantage of any gain in this direction must not be overlooked in view of the socialistic tendencies of the present time. Riots and strikes are of frequent occurrence, while the evils of socialism and communism are

rapidly spreading over this country, as they have already done in Europe. There it has required a strong military force to hold these elements in check. To meet and control this growing evil will be the duty of the young men of the present time.

Men of combined intellect and education have always been the leaders of their parties at all times of political trouble. It is a deplorable fact that a spirit of lawlessness often manifests itself among our college students. In colleges where there is a military department, this spirit is, to a certain degree, kept in check, and if, as young men, they are taught that laws and regulations are made to be obeyed and respected, when they graduate from college and pass out into the world, they will be better citizens of the republic, as well as of their respective States; men whose influence will be thrown on the right side of the scales when the necessity for action arises. In this eminently practical age, men are apt to cast aside the abstract or ideal benefits of the future, for the practical advantages of the present. That the benefits of a military education are practical no one will deny if he will but consider them.

What are the benefits that the student gains to pay him for his time? Take the drill as a method of physical training. Of late years the attention given to this subject has been greatly increased. Many of our larger colleges now have gymnasiums, fitted with all the appliances for improving the physical condition of the students. A competent instructor is in charge, who grades the work according to the individual necessities of the students; yet even in these gymnasiums a portion of the work is of a military character. I do not contend that the military drill will do this important work as well as a thorough gymnastic training, but I do claim, that where a specified amount of work in a gymnasium, under a competent instructor, is not compulsory, the military drill fills a very important place in the college course. Close students are apt to neglect proper exercise, and, consequently, when they leave college, although the mind may be well trained for mental work, the muscles are flaccid, the heart's action is weak, and the lungs are in such a condition that some kind of pulmonary disease is almost a certainty. Under these circumstances, the college graduate is unable to do the work expected of him, and his life becomes at least a partial failure.

As a physical exercise, the new "Drill Regulations" are an improvement over the old "Tactics." The "setting up exercises," which were but four in number, were designed to straighten the back and shoulders, and give an erect carriage. This they did with a result that the lungs had plenty of room in which to expand, and the heart was given the opportunity for good healthy action. But they did not go far enough as a method of physical training. This lack

has now been supplied, and, instead of four, there are seventeen exercises by which almost every set of muscles in the body is brought into action.

Walking has always been recommended as a good, healthy exercise, and this the student obtains in his company and battalion drill, and, where the military drill is compulsory, every student is obliged to take a certain amount of it.

In the agricultural colleges many of the students have to work in order to help defray their expenses. Much of the work so done, while it may strengthen some few sets of muscles, does not have a tendency to better the physical condition of a growing boy, and for these students the military drill has an especial value, not only when they are students, but furnishing them, when they leave college to follow an agricultural life, with a body better fitted to endure the laborious life of a farmer, than they would otherwise have had. In all branches of life the beneficial effects of the military drill are acknowledged by all who have taken it. From personal inquiry among many of the alumni of the Massachusetts Agricultural College I have failed to find one who does not think that military drill has been of great benefit to him, and through correspondence with all the army officers on college duty I find that this is the general feeling.

But the physical training is not all the advantage that the college student obtains from his military drill. As a private, when he first enters college, he is taught by strict military discipline to control himself. He sees the necessity for self-control in those who hope to lead and command others. When he becomes a senior, and is himself placed in positions of authority, it is impressed upon him still more strongly, by actual experience, that if he would successfully command the prompt obedience and respect of others, he must first set a good example by controlling himself, and thus he learns one of the greatest of life's lessons.

The desire to hold an office in the cadet battalion, the efforts put forth in order to satisfy this desire, and the gratification experienced, when, the end attained, he realizes how much pleasanter it is to be in a position to command others than to occupy a subordinate one, are but the foundation stones of a lifelong desire to be a leader among his fellowmen, wherever his work may lead him. As an officer, he has more or less responsibility thrust upon him, and thus early in life learns self-reliance. When his college days are ended, and he enters the arena of life, where full success only comes to the few who by steady, persistent effort obtain it, he, reliant on himself and confident in his ability, chooses his life work, and, undeterred by partial failures, and keeping his end steadily in view, works on until success finally crowns his efforts.

In this practical age every man, no matter what his profession or business may be, must commence at the foot of the ladder, gaining the top only by stepping from round to round. As a young man makes his value more and more evident to his employer, just so fast and no faster is he advanced. What better qualifications can a young man possess to commend himself to his employer than punctuality, promptness, quick obedience to directions given him, courtesy, and last, but not least, that straightforwardness of manner, which, — while lacking the boldness of what is commonly called "cheek," yet shows that the possessor is doing his best, — has acted as he thought right, and having so done is willing to be judged by the result of his work.

These qualifications are all brought out to the greatest possible extent in the character of a successful military student, while all may have them inculcated to a certain degree, thus increasing to just such an extent their chance of success. The head of one of the largest mercantile firms in New York said to me that he would consider an employee who had had a good military education as worth a larger salary, to do the same kind of work, than one who had not had such a training.

Young men are sent to college, not only to obtain a technical knowledge of the different sciences from a study of books, but a broader knowledge of the world and human nature; to bring out and increase those traits and characteristics that distinguish true, fully-developed manhood from the spurious article, which is weak and unable to grasp the opportunity for success when it is presented.

The military department, which does this work to a great extent, should be placed on a par with the other departments, both in regard to the time allotted to it, and the interest shown towards it, by the other members of the faculty. The professor of military science and tactics should be loyally supported by the authorities in matters of discipline, and the students be thoroughly impressed with the importance of this department. The officers should be carefully chosen from those who, not only by their technical knowledge of minor tactics, but also by their personal characteristics, have shown their ability to assist the head of the department in his important work. They should be men who, as officers, will command the respect of those under them, and reflect credit on their college. Under these circumstances the officer's commission would be a prize eagerly sought after, and, once obtained, too highly valued to be lost through poor work.

In order that the greatest benefit may be derived from the military department, both by the college and the students, its scope should be extended to the greatest possible degree. Make these agricultural

colleges military to such an extent that the students shall be required to wear the proper military uniform, and be under military discipline whenever they are on the college grounds. When this is done, and not till then, will the idea of those statesmen, under whose fostering care these agricultural colleges were started, reach its highest development and bear its most perfect fruit.

TUBERCULOSIS,

With Especial Reference to the Disease as seen in Cattle and Other Domesticated Animals.

When we remember that tuberculosis is an infectious disease, and that one-seventh of all persons born die of it, that it exists largely among our domestic animals, especially the bovine race, and when we consider the close relation that exists between the people and their cattle, how close the contact, how great the dependence of the human race upon the bovine for their products which are used as food, and that the germ which produces this terrible disease may be transmitted from one person to another or from one animal to another, or from animal to person; it seems that no apology is necessary for the appearance of a second paper upon the subject in the annual report of the college.

The term tuberculosis has reference to a disease in which we have formed, as a result of the pathological processes, in different parts and in different organs of the body, little knots, nodules, or tubercles. For the same reason the disease is frequently designated pearl disease, kernels, or grapes. When the nodules are very small, it is spoken of as miliary tuberculosis, from the resemblance the little nodules have to millet seed. When the tubercles are in the lungs this disease is designated phthisis, phthisis pulmonalis, or pulmonary consumption. When in the intestines, or the mesenteric glands, tabes mesenterica is the name applied. If the articulations are affected, tuberculosis arthritis or bone disease. When the lymphatic glands become inflamed and nodular, the term scrofula is used. If in cows the ovaries are the seat of the tuberculous changes, constant rut or heat is produced, and such animals are designated nymphomaniacs. Tuberculous inflammation of the coverings of the brain or spinal cord constitutes tuberculous meningitis. As one of the prominent symptoms is general unthriftiness and emaciation, the disease is frequently called pining or wasting. All of these tuberculous processes, or what is commonly termed consumption of the lungs, bowels, ovaries, or joints, are identical, except as regards their location.

When the disease is present in only one or two places in the body, it is said to be local; when it has attacked many of the organs, or is

widely spread throughout the whole system, it is spoken of as general tuberculosis.

Etiology.

In treating of the etiology of tuberculosis, we have to consider the exciting and predisposing causes. The exciting cause is the one that actually gives rise to the disease. The predisposing causes are the ones which, acting upon the animal, make it susceptible to an attack, or to the development of the disease.

The exciting cause of tuberculosis is a vegetable germ which gets into the body, localizes itself, and by its growth, development and action on the tissues in which it is located, produces the peculiar lesions which we term tubercles. In 1882, Dr. Robert Koch, a German bacteriologist, after years of careful study and experiment declared that no true tuberculosis could exist unless this germ was present. In other diseases where nodules are produced, the lesions are spoken of as *tubercular*, but all genuine tuberculous processes belong to tuberculosis, and are, in all cases, produced by this particular germ. However, the two terms "tubercular and tuberculous" are used synonymously.

The germ, the active principle of the tuberculous virus, belongs to the class of micro-organisms called bacteria, and to a sub-class called bacilli, from the fact that they appear as little rods under the microscope. They are very small, only about one six-thousandth to one ten-thousandth of an inch in length, and only about one-sixth as broad as they are long. From the fact that they alone can produce tuberculosis, and only this disease, they have been named the tubercle bacilli.

The germs can be cultivated outside of the animal body on prepared blood serum, or on gelatinized meat broth which contains from three to five per cent. of glycerine. In order to do this it is necessary to get tuberculous material from some place where it has not been contaminated by other germs, from the air or other sources. This material is placed upon the nutrient media, and then placed in an incubator, where a constant temperature of 98° F., the normal temperature of the body, can be maintained. If the temperature gets below 86° F., or above 105° F., their growth ceases. After two weeks or so, by microscopic examination, small, whitish grains are seen upon the surface of the nutrient material. These little grains continue to increase in size and finally form a thick, dry, lustreless coating, which, upon higher magnification, is found to be composed almost wholly of tubercle bacilli. If some of this material is introduced, under antiseptic precautions, into the abdominal cavity, the circulation or into the anterior chamber of the eye of an animal that is susceptible to tuberculosis (the rabbit, Guinea-pig, mouse), in a varia-

ble time, from a few days to a few weeks, the animal so inoculated will be found, upon post mortem examination, to have well-marked tubercles in different parts of the body, depending upon the place chosen for inoculation and the number of bacilli introduced. In these tubercles may be found germs with the same characteristics as those which grew on the nutrient material, and with which the animal was inoculated. If fresh, uncontaminated material which contains the micro-organism from the diseased animal be introduced into the circulation of a healthy one, it also will show well-marked lesions characteristic of the disease. Material for cultivation may also be obtained from these experiment animals, which, when planted upon suitable media, will grow and produce the peculiar whitish grain-like colonies noticed in the original culture.

As the tubercle bacillus requires a temperature of 86° to 105° F. for a considerable length of time for its growth, it cannot multiply outside of the animal body under ordinary conditions of nature.

It is important to bear this in mind, for, unless the germ be present, we can have no tuberculosis. Again, as the germ cannot multiply except under very favorable conditions, tuberculosis cannot spread to any great extent except by presence of a tuberculous patient. On the other hand, when the germs do become scattered in a locality, it is very difficult to get rid of them. While they do not increase in number outside of the body, they are very resistant against the forces of nature which readily destroy many micro-organisms.

It has been found that the bacilli in the sputum from a tuberculous person may retain their vitality, even after having been dried for months. At the same time it requires a temperature near the boiling point of water to kill them. Decomposition does not destroy their vitality but sets them free from the tissues in which they may be situated. Unlike most bacteria, they can withstand the action of the acid, gastric juices in the stomach, and still retain their infectious qualities. This explains how the disease may develop in the intestines or the mesenteric glands, when animals are fed with the products of tuberculous subjects.

It has generally been supposed that the tubercle bacilli produced spores, and that while the germs themselves were destroyed by drying, heat and cold, the spores retained their vitality, and that when placed under favorable conditions they would germinate, grow and multiply. Our knowledge of the subject at present does not warrant our saying for certain that spores are produced by the bacilli. The process which has been described as sporulation has probably been one of vacuolation.* Practically it makes but little difference,

* Multiplication of air-cells.

for we know that the germ can withstand the action of cold, a high degree of heat, the process of decomposition and digestion without being destroyed. This is accounted for by the fact, which has been discovered in staining, that the cell wall or covering of the germ is very tough and resistant. These peculiarities of the bacilli, also explain why it is so difficult to rid a stable of the infectious principle when once the germ becomes scattered about it by tuberculous animals or persons. For this reason, when the material, which contains the germ of the disease from a consumptive subject, becomes scattered about the house in which the person lives, the disease is very likely to remain a long time in the locality. The matter in which the micro-organisms are held, decomposes, dries, disintegrates into dust, and the bacilli are set free; they become mixed with the dust and for a long time retain their infectious qualities, and when brought under favorable conditions they grow and multiply. These favorable conditions may be in the lungs or in the blood of a susceptible animal or person. As soon as they become dry and mixed with the dust, they may be set in motion by currents of air and produce the disease by being breathed into the lungs, or what is rather more unusual, by getting into the circulation through some abrasion of the skin or mucous membrane, or being taken into the alimentary tract with the food.

That we are dealing with facts, supported by accurate experiments has been proved by Cornet. He ascertained that the tubercle bacilli are not scattered all about us, only waiting for favorable conditions for development, but that they are only met with in well-defined circumscribed regions, the centre of which is a tuberculous animal or person. It is a well-known fact that the sputa coughed from the lungs contain great numbers of the bacilli.

He further proved that the dust of houses in which consumptive persons lived contained the tubercle bacilli. This was done by introducing small quantities of the dust into the abdominal cavities of Guinea-pigs, and in every case where the dust came from houses inhabited by consumptive persons tuberculosis followed. The inoculation with dust from houses not inhabited by consumptives gave no tuberculosis when introduced into the abdominal cavity of the pig.

This same investigator, after having proved that the germs were present in the dust of houses inhabited by consumptives, clearly demonstrated how they become scattered. This is by two means; expectorating upon the floor, or what is more common and a more dangerous procedure, expectorating into the handkerchief, for there the most favorable conditions exist for the drying of the sputa and the conversion of it into dust by the repeated use of the cloth. He, also found that the bed-clothes on which the handkerchief lies during

the night ready to be taken up during paroxysms of coughing was a fruitful place for the deposit of tubercle bacilli.

The views of Cornet have been supported by the work of others who have made a careful study of the subject. They have found that in certain sections of a city tuberculosis may be very common among the inhabitants, where the sanitary conditions were less favorable to its development, than in some other part of the place where little would exist.

Just how the bacilli produce the characteristic tubercle of this disease is not known. Probably it is something as follows: The germs get into the body and are carried along by the fluids or by wandering cells, into the cells where tuberculous inflammation follows their growth and multiplication. As a result, there is a destruction of the original cells of the tissue and the production of lymphoid, epithelioid cells, and a peculiar body called a giant cell, in which the tubercle bacilli are usually located. The tuberculous nodules are devoid of newly formed blood vessels, and the old ones leading to the part soon becomes impervious. By the action of the tubercle bacilli other changes follow which come under the head of cheesy degeneration and necrosis. The cells in the central part of the nodule lose their nuclei and degenerate into a hyaline or granular mass. This necrotic portion is surrounded by a zone of epithelioid cells associated with giant cells, and these in turn are surrounded by lymphoid cells. These small nodules may increase in size by growth around the periphery; but large tumor-like tuberculous masses are produced by the coalescence of a number of small tubercles. The whole process is one of tuberculous inflammation, and, as described, usually produces miliary tubercles, but may, in certain organs, produce diffuse masses of tubercle tissue, which are called infiltrated tubercles, to distinguish them from the miliary nodules.

The cause and development of the disease depends largely upon the manner, the number of germs and the condition of the animal's system at the time they gain access to the body. In cattle, and in fowls especially, the tubercles tend to become calcareous from the deposition of lime in them.

The exciting cause of the disease in all persons or animals is the same; without the tubercle bacilli there can be no true tuberculosis.

The Predisposing Causes.

Species of Animals. — The bovine race, of all our domestic animals, is especially liable to this disease, as much or more than members of the human family, and the question as to its identity and its transmission from one race to another is practically settled.

Fowls come next in order of susceptibility, and not only do we find the disease common in ordinary barnyard fowls, but in pigeons, pet house-birds, and other pet animals, like the rabbit and Guinea-pig, when kept in domestication.

Pigs contract the disease readily, but from the fact that they are slaughtered early in life the disease rarely reaches great development, and frequently the tubercles are so small that they are not noticed upon casual examination.

Tuberculosis is rarely found in the cat, dog or sheep. It is found less frequently in the horse than in other domestic animals. In fact, only a few authentic cases have been reported in which the tubercle bacilli have been found, in the diseased nodules, in this animal.

Hereditary Predisposition.

That there exists in a person or an animal born of tuberculous parents a predisposition to acquire the disease more readily than one born of perfectly healthy parents, is a fact so familiar that the expression "belongs to a consumptive family," is frequently heard. It is the opinion of some that hereditary tuberculosis can be accounted for in this way:—The micro-organisms get into the system during the intra-uterine period, and remain dormant in the tissues until some change, either chemical or physical, takes place in the body which favors their growth. This change may not come about for years, but when it does the disease develops.

Dr. Koch throws some light upon this point in his "Etiology of Tuberculosis." He says, "No facts exist which justify the supposition that intra-uterine or extra-uterine tuberculous bacilli can be present in the organism of a child without bringing about visible changes in a comparatively short time. But until now tuberculosis has been very seldom found in the fœtus or the newly born child, and we may, therefore, conclude that the infectious material has effect only exceptionally during intra-uterine life. This supposition is confirmed by the fact that of my experimental animals, especially Guinea-pigs which were pregnant before or after tuberculous infection, none have ever borne young which were tuberculous at birth. The young coming from mothers tuberculous to a high degree were free from tuberculosis, and remained healthy for months. In my opinion, hereditary tuberculosis finds its most natural explanation if it be supposed that not the infectious germ itself, but certain qualities favoring the development of the germ, coming into contact with the body at a later period, therefore, that which we call disposition, be inherited." What there is in Koch's experiments that is applicable to the human race seems, also, to apply to the bovine.

If we are to rely upon his work and that of other bacteriologists in relation to hereditary and congenital development of tuberculosis, it would seem that the germ is seldom found in the fœtus, and that it is not the bacillus that is transmitted from the parent to the offspring, but the condition of the system which favors the growth of the parasite within it, and of which we speak as hereditary predisposition or tuberculous diathesis. But it matters not how great the predisposition, tuberculosis will never develope in such an individual unless the exciting cause is present.

That congenital tuberculosis is rare may be inferred from the fact that only one or possibly two cases are on record.

Proximity to Tuberculous Animals a Predisposing Cause. — Every animal suffering from disease is a centre of infection for others. They may give out from the body living germs which may gain access to a healthy animal, and in it give rise to the malady. An animal or person having the hereditary predisposition would be the one most likely to suffer by coming in contact with the affected.

After years of careful study of the subject, Dr. Brush says, "If a community is closely associated with in-bred dairy cattle, tuberculosis prevails."

Domestication. — Animals in the wild state are rarely affected, but as soon as brought under the influence of domestication, in contact with the human race, in which the disease is so prevalent, they soon become subjects of the disease. In cattle is this especially true, and those running at large on our western plains furnish us with a good example. Among them it is not often the disease is found, but as we come East into a thickly populated territory, or go into the cities where the cattle are more under the influence of domestication, we find a greater number affected. This effect of domestication is not alone seen in cattle but also in wild animals, like the lions, monkeys and birds. Frequent reports of the deaths of these animals from this cause come from our zoölogical gardens.

Breeds. — No breed is exempt from the disease, but some are more susceptible than others. In Jerseys and Guernseys this susceptibility seems most marked, but perhaps not more so than in some strains of Shorthorns which have been bred in a particular line for a long time. What applies to the Shorthorns also applies to the Ayrshires. While in the Herefords, Devons and Holsteins the disease is by no means rare, it is not as prevalent as in the breeds first named. Our hardy native stock, the common grades of New England, are as free from it as any. Breeding-in, as practiced by some breeders, is a predisposing cause, from the fact that such a course tends to weaken the constitution or lower the vitality of the tissues of the body, and makes them less able to thwart the attack of the germ or

any external influence that might cause disease. Again, breeding in and in from affected animals would increase the dangers arising from hereditary predisposition.

Early, late and over-breeding of animals predisposes them to an attack of tuberculosis because it tends to weaken the constitution so that once the germ gains admittance to the body there is not that opposition on the part of the tissues, to the attack of the invader, that we see in a rugged, healthy animal.

Allowing heifers to breed too young prevents their strong, full and normal development. Breeding from old cows which produce large quantities of milk, and whose bodies in consequence are not strong, will give small, weak calves that are particularly liable to contract the disease, and, furthermore, the mother on account of her depleted condition is predisposed.

Physical Conformation or what is commonly termed, the Build of an Animal. — Those with disproportionately long legs and narrow chests, are predisposed to the disease. The same is seen in human beings. Narrow-chested, round-shouldered people who have small lung capacity are more subject to this affection than those with full chests and square shoulders. Still, what may be considered a faulty conformation in cattle may be the evidence of the tuberculous diathesis which the animal may have inherited.

Debility is a predisposing cause, whether the result of excessive milking, deficiency of food, food poor in quality, weakness following parturition, loss of blood, purgation or previous disease. All of these influences acting together cannot cause the disease, but they so lessen the vitality of the animal, and produce such changes in the body as render it more liable to the invasion and multiplication of the parasite.

Bad sanitary conditions are classed as fruitful predisposing causes of tuberculosis. With the great improvement made in the last few years in the construction of stables, there has not been a corresponding improvement in the methods of draining, lighting and ventilating. In older stables, built of rough boards, air could easily pass in and out of the building, but by the use of matched boards, building paper and clapboards, this is prevented and oftentimes we find the front of the mangers tightly closed, so that the animals are compelled to stand in a small, close space, surrounded by an atmosphere heated by their bodies and containing the impurities that come from the bodies, lungs and excrement. All of these conditions have a depleting effect upon the system. If tuberculosis gets among animals kept under such hygienic circumstances, it usually spreads rapidly, and generally runs a very acute course. Whereas, if the same herd of animals is put into a stable where there is sufficient light, pure air and good drain-

age, the spread of the disease from sick to healthy is greatly lessened, and in some animals, only slightly affected, there may be appearances of recovery. Too much cannot be said on this point, especially where the disease has made its appearance in a herd. Good hygienic surroundings will more surely prevent the rapid spread of the trouble than will the use of quantities of drugs.

Climate and Locality. — Statistics go to show that, while the dread disease exists among nearly all people and all cattle, it is much more common in some climates and in particular localities. It is more prevalent in tropical than in colder regions, most seen where the climate is changeable, where there is a great range and sudden changes in temperature. Climatic conditions like our own favor the development of it, while the equable temperature and dry air of Colorado prevent its rapid spread.

In and about our large cities the cattle are more largely affected than in the country towns, for the reason that they are closely crowded into badly-lighted, poorly-drained, and ill-ventilated stables, where they are compelled to remain throughout the whole year, not being allowed the advantages of a run in pasture. In such places the methods of feeding, forcing the animal to produce a large quantity of milk, tend to undermine the health.

The practice among cattle dealers of the State of exchanging new milch cows for farrow ones in the cities, and taking the latter out into the country, is fast increasing the number of diseased animals in some of our western towns. It is also spreading tuberculosis among the healthy herds of the State. The affected animal, poor in flesh, from the city is represented by the dealer to be in this emaciated condition from the process of forcing; she is offered at a low price, and the unsuspecting country farmer, in consideration of the price and the promise in some cases to repurchase after calving, buys the animal and innocently introduces into his herd a contagious and fatal disease, which will be difficult to eradicate and which in time will destroy his entire herd.

Means of Infection and Propagation of Tuberculosis.

The principal method of infection is by the inhalation of dried tubercle bacilli into the lungs. Wherever we find it spreading among cattle, the lungs or the bronchial glands are the first organs affected. It has been shown that the germs retain their vitality after months of drying, and then, by becoming attached to particles of dust, can be floated in the air for a considerable time. In this condition they are inhaled. To be sure, many may be removed again from the lungs, without doing harm, by being mixed with the secretion of the mucous membrane, or by the cillia on the epithelium, covering the mucous

lining of the bronchial tubes; but such is not always the case. If in the lungs there is a small diseased spot of low vitality, with which they may come in contact, they will germinate and produce tubercles. These increase in size and number, several coalesce, their walls finally break, and the contents of the tubercles are discharged into the bronchial tubes, where it is mixed with the mucous secretion. From here it finds its way to the throat and is expectorated or swallowed. In either case they are finally set free from the body and may under favorable conditions infect other animals.

In Koch's etiology of this disease we find the following statement referring to the source of tubercle bacilli, and means of infection and propagation among animals: "The animals, as is well known, produce no sputum, so that during their life no tuberculous bacilli get from them into the outer world by means of the respiratory passages." My own experience has proved differently, and, while they may not produce what we term sputa, as applied to the human production, consisting of pus and mucous coughed from the lungs to the mouth and then expectorated, they do have a discharge from the nostrils which in many cases contains the bacilli. This material has the consistency of mucous, is slightly stringy and steel gray in color, from the admixture of particles of dust which are taken in with the inspired air. Under the microscope pus cells are rarely found, showing that the material does not come wholly from broken down tubercles in the lungs, but is probably mucous from the bronchial tubes. Stained cover glass specimens show numerous bacilli.

During the past few months I have diagnosed several cases of the disease in cows by this means, when other pathognomonic symptoms * were wanting. I have also found that this material coming from the nostrils may become spread about the manger, getting upon the woodwork, or the feed in the immediate vicinity of the animal. The tubercle bacilli are set free by drying and become mixed with the dust of the stable, which is frequently set in motion by the moving of hay, sweeping, etc. The particles of dust, with the tubercle bacilli attached, floating in the air are inhaled into the lungs or they may be taken into the alimentary tract with feed to which they may have become attached.

From the fact that in cattle the greater proportion of cases of this disease first develops in the lungs or the neighboring lymphatic glands, I conclude that it is mainly propagated by the escape of the germs with the mucous from the nostrils, and that the principal method of infection is by the inhalation of the dry bacilli.

A second method of infection is by ingestion, — by taking into the stomach food or other material which contains the living germs. As

* Symptoms indicating with certainty the disease which produces it.

already mentioned tubercle bacilli differ from many others in one particular, — they are not destroyed by the action of the gastric juices in the stomach, and can pass into the intestines, multiply and produce the disease if the conditions are suitable.

It has been found repeatedly that feeding tuberculous products to susceptible animals will produce the disease. Human sputa containing the germs, fed to fowls will produce tuberculosis. Tuberculous meat or milk will give the same results if fed to calves or Guinea-pigs. Taking all of the facts into consideration, we may be sure that milk or meat containing the bacilli may produce the disease in human beings especially in young children.

The work of Doctors Ernst and Peters for the Massachusetts Society for Promoting Agriculture, in relation to tuberculous milk and its effect upon animals is very interesting and instructive.

They have demonstrated

"*First*, And emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.

Second, That the virus is present whether there is disease of the udder or not.

Third, That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.

Fourth, That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk, in cows affected with tuberculosis, but with no discoverable lesion of the udder."

The results obtained from certain feeding experiments with calves, show that there were thirteen calves used, and fed for varying lengths of time with milk from cows affected with tuberculosis, but not of the udder. Of those so fed 41.66 per cent. were found upon *post-mortem* examination to be diseased. In the same experiment, with pigs 40 per cent. gave positive results.

Infection by inoculation occurs when the germs gain entrance to the body through some abrasion of the skin, — it may be intentional or accidental. Intentional inoculation is made upon susceptible animals, like the rabbit and Guinea-pig, for the purposes of investigation or study. Accidental infection may take place in the human, in making *post-mortem* examinations, if the skin is cut with the knife or scratched on a sharp piece of bone; or it might occur in slaughtering affected animals, if there was a sore on any part of the body through which the virus could get into the circulation. It does not appear that the disease is spread to any great extent among animals by this means of infection. However, if there be an abrasion of the skin or mucous membrane, there is no reason why the germs should not get into the circulation in such a case, and produce the disease, as well as in man or in animals intentionally inoculated.

Diagnosis of Tuberculosis in Cattle.

In the early stages of this disease pathognomonic symptoms are usually wanting. It is insidious in its attack and may easily be mistaken for some other trouble.

Diagnosis may be made by physical examination, or by finding tubercle bacilli in the mucous that comes from the nostrils, in the milk, in pus found in sub-cutaneous abscesses that at times form in different parts of the body, or in the excrement of the animal. The method by physical examination is the most common, and the one generally relied upon. For making microscopical examinations for the bacilli the reader is referred to Koch's "Etiology of Tuberculosis," or to any of the treatises on bacteriology, particularly Fraeknel's.

In making this examination for the tubercle bacilli, we have to allow for their accidental appearance in the material examined. This is not likely to occur, and any doubt may be removed by making several examinations at intervals of two or three days. When it is found upon repeated examination of any product of an animal that the bacilli are present, it is conclusive evidence of the existence of tuberculosis. But the absence of, or failure to detect, the germ is not as satisfactory evidence of the absence of the disease as is their presence of its existence.

The physical signs or symptoms vary greatly in different cases and depend largely upon the constitution, state and keeping of the animal, the organs affected and the course of the disease, whether acute or chronic.

In the first stages of it in any form it is difficult to diagnose by the physical symptoms, but as the disease progresses there are certain general symptoms usually found in all cases.

In the first stages the animal is noticed to be ailing, there is marked dullness, want of life, as shown by the movements about the stable or yard, the hair is rough and erect, the skin harsh and dry, there may be slight fever (which lasts for only a few days and then disappears), heat of the horns and dryness of the nose. A thermometer inserted into the rectum or vagina and allowed to remain for five or ten minutes will show that the internal temperature is 102° or 103° F. The pulse may be quickened, fifty or fifty-five beats to the miuute; respirations more frequent. All of these symptoms are those of fever, are common to many other diseases, and are not a constant or characteristic sign of tuberculosis. As the disease progresses there may be a dry, deep, husky cough at varying intervals, perhaps at first it may not be heard more than a few times a day, bnt is most noticeable when the animal

is compelled to exert itself or is allowed to go from the stable into the fresh air. The lymphatic glands in different parts of the body may become hard and nodular, especially those in the sub-maxillary space, or those in front of the shoulder at the base of the neck, or in the flank.

Upon further development of the disease, the animal becomes emaciated, hide-bound, hair more erect, the eyes sunken in the sockets from loss of fat, and the mucous membrane becomes pale and bloodless. If the lungs are badly diseased, the cough becomes more frequent, the respiration shorter and sharper, especially noticeable if the animal is made to exercise. If the ear is applied to the sides of the thorax a dull, harsh murmur is heard over the diseased portions of the lungs. When large areas are involved the natural respiratory murmur may not be detected at all, only tubular sounds. If there is considerable tuberculous pleuritis a fine rasping sound, like that produced by rubbing the hair between the thumb and finger, may be noticed. Percussion of the chest walls between the ribs may produce pain as shown by flinching. Percussion over consolidated areas gives a dead, dull sound in place of the natural resonance. If cavities exist in the lungs there is increased resonance. The digestion becomes impaired, the appetite is fickle, attacks of indigestion are common, and there may be constipation or a diarrhœa, while tympanitis or bloating follows eating or drinking. The secretion of milk may not be greatly disturbed, garget without any apparent cause may appear, and lameness and swelling of the joints may often be noticed.

When the ovaries in the cow are diseased the animal shows signs of persistent heat, and may take the bull, but conception and the completion of gestation are uncommon.

In the male the testicles may be the seat of the disease. When such is the case, they become hot, tender and inflamed. Such animals are useless for breeding purposes.

In the last stages, all of the symptoms become aggravated, the animal may become very poor and weak, the cough more frequent, loose and rattling. If the ear is applied to the side of the thorax in this stage, the natural respiratory murmur is not heard, only tubular breathing and a distinct rattling or gurgling sound. Percussion shows large areas of the lungs which have become solid. The respirations are very rapid, short and labored. Profuse fœtid diarrhœa is marked, if the intestines are the seat of the disease.

In this condition the animal may live for several weeks or months, gradually growing poorer and weaker, until death follows, — the result of exhaustion, pyæmia or diarrhœa.

From the complexity of the symptoms enumerated, it is quite a difficult matter for the inexperienced to diagnose the disease. But

there are, in some cases, certain well-marked, distinct symptoms of the malady, by which one ought with some degree of certainty to form a correct opinion, provided he knows that tuberculosis does, or has at some time existed in the herd.

The first and most important sign of the ailment is a chronic cough. When this is found with general unthriftiness and loss of condition, it is quite enough to cause the animal to be separated from the others.

Another characteristic symptom is recurrent tympanitis,* which appears after eating or drinking, without apparent cause (such as change of food, eating of turnips, potatoes or other vegetables), and is not cured by the ordinary purgative treatment, for tympanitis, the result of indigestion. Bloating in these cases is caused by the pressure of the enlarged tuberculous, bronchial lymphatic glands on the œsophagus, which passes between the glands and the roots of the lungs, thereby preventing the natural escape of the gas through the œsophagus from the stomach.

Frequent attacks of constipation followed by chronic diarrhœa should be regarded as almost a sure symptom, showing a tuberculous condition of the int estines and mesentery.

A cow in constant heat that fails to conceive should be looked upon as suspicious, and especially so if there are other signs of the disease present, such as a cough, tympanitis, or enlarged lymphatic glands.

Chronic mammitis or garget, which comes on sometimes after calving, and which does not proceed from change of feed, overstimulating food, or injury, and which does not respond to the usual treatment, may be considered an important symptom of the presence of tubercles in the udder.

An animal in the herd that becomes lame and has a hot, tense, painful swelling of any of the joints of the legs, not produced by an injury or any known cause, may be suspected of being tuberculous.

Any of these individual symptoms may proceed from other cause than tuberculosis, but if there is a history of the disease in the herd as shown by *post-mortem* examination, and if any of them appear in an animal independent of any known cause, it should be separated at once from the healthy ones and kept isolated until known to be healthy.

Treatment.

Tuberculosis in cattle is an incurable disease, and treatment should not be attempted. In the early stages an animal slightly affected may, by being kept under the best of sanitary conditions and properly fed, apparently make a good recovery; but in such the disease is only in a dormant state, and will break out and spread rapidly throughout

* Bloating.

the whole body when the condition of the system becomes so changed that it will tend to promote the growth and multiplication of the germs. In dealing with this disease, we should always remember that a tuberculous animal is a source of danger, as a centre of infection to other animals and to persons coming in contact with it, or to those using the milk or meat.

About a year ago a great sensation was created by the startling news that Dr. Koch had found a certain cure for consumption. His idea was to separate from the material upon which pure cultures of tubercle bacilli had grown certain substances produced by the growth of the germ, mix them with glycerine or other suitable material, and then inject it into the circulation of a tuberculous subject. He claimed that this peculiar agent would so affect the diseased tissue that it would be separated and removed from the healthy tissue, and a cure of the disease would follow. While it has doubtless in some cases of human tuberculosis produced favorable results, it has by no means proved as valuable as was first expected. In cattle it has no value as a curative agent. In fact, its use seems to induce a speedy development of the disease when latent in the system. It has in some instances proved of value as a means of diagnosing the disease in suspicious cases. But here the results are not always reliable.

Some interesting experiments have been made in the veterinary department of the University of Pennsylvania with *tuberculin* (the name applied to Koch's remedy), to test it as an agent for the diagnosis of tuberculosis in cattle. As a result of these experiments the following conclusions are given:

First, That the injection of tuberculin in cows suffering with tuberculosis produces a febrile reaction

Second, That healthy cows do not give a reaction with moderate doses.

Third, That in some instances, tuberculous cattle fail to give a reaction with ordinary doses of from 300 to 500 milligrammes.

Fourth, That injection of the tuberculin causes the rapid distribution of the tubercle bacilli and a generalization of the disease.

Fifth, That in none of the tuberculous animals used in the experiments could the least curative effect be observed.

Sixth, That cows cease to react after repeated injections of the tuberculin.

Seventh, That tuberculin is of value in the diagnosis of tuberculosis in cattle.

Other investigators have not obtained as good results as those quoted, and, until more work has been done in this direction, it is not likely that tuberculin will come into general use as a curative or a diagnostic agent.

Post-Mortem Appearances.

To the naked eye these vary according to the species of animal and the extent and location of the disease, but under the microscope the diseased tissues have the same appearance regardless of their origin. I shall only describe their microscopic appearance.

The appearance of the tubercles in the lungs vary according to the changes that have taken place in them. When of recent formation they may be no larger than a millet seed. In this stage they appear irregularly spheroidal in shape, the very small ones gray and semi-transparent, while the larger ones are opaque, whitish or yellow, particularly in the centre. As they grow larger they undergo a cheesy degeneration, break down in the centre, and we frequently find them containing creamy yellow pus. In cattle especially they tend to become calcareous from the deposition of lime in them. In this case when cut open one will notice a distinct gritty feel about them. The smaller ones coalesce and form large tuberculous tumor-like masses, which in some cases may be six or eight inches in diameter. Usually in the centres of these masses pus in very abundant. When these tubercles break down the pus frequently escapes into the bronchial tubes, so that in *post-mortem* examination we may find it in the bronchial tubes mixed with the mucous.

When the tubercles form on the surface of the lung or the pleura covering the ribs, the new tubercles appear at first as small red spots. These increase in size so that in some cases they become as large as a hen's egg, and so numerous that the whole surface of the lung or the wall of the chest will be completely covered. These are less likely to contain pus than those in the lungs. In some instances, the lungs are found to be attached to the chest wall by these new growths.

Tuberculous bronchial glands are frequently found, and are usually present when the lungs are diseased. They are situated over the lungs at the superior part of the thoracic cavity, extending along the vertebral column. They may be greatly enlarged and weigh as much as fifteen or twenty pounds, and are hard, nodular and full of yellow, cheesy matter. In other cases they may be enlarged, but, upon opening them, little caseous material is found. Instead there will be large quantities of yellow pus, amounting sometimes to two or three pints.

The tubercles on the peritoneum, the lining of the abdominal cavity, closely resemble those found on the pleura. Where there is general tuberculous peritonitis, one usually finds a profusion of thin, serous fluid in the abdominal cavity.

Tuberculous nodules in the spleen are quite frequently of the miliary variety, very small and grayish white in color. If a one per cent.

watery solution of iodine and iodide of potassium (one part of iodine, three parts of iodide of potassium, one hundred parts of water) be poured over them, they are more easily distinguished from the surrounding tissue by their bright mahogany color.

Tuberculous mesenteric glands do not differ greatly in their appearance from tuberculous lymphatic glands.

Tubercles in the liver, kidneys and other organs closely resemble those already described.

Tuberculosis in the horse seems to occupy a place between that of man and the bovines. The tubercles that are found, *post-mortem*, on the omentum and peritoneum and mesenteric glands resemble those found in cattle. The conditions of the bronchial gland is similar, while in the lungs, instead of finding large tumor-like masses, the tubercles are usually of the miliary variety.

The nodules of tuberculosis somewhat resemble the nodules found in the lungs of horses affected with chronic glanders.

Tuberculosis of the pig is recognized after death by the caseous condition of the lymph glands of the neck, and by a peculiar form of caseous pneumonia, in which the lung becomes infiltrated with grayish-red or grayish-yellow cheesy material, which completely fills the air cells and the space between the lobules.

In sheep the lungs and bronchial glands are affected most and the appearance is nearly the same as in cattle.

In making autopsies on sheep, one is liable to confound tuberculosis with two other diseases, one affecting the lungs and the other the intestines, from the fact that the lesions, to the naked eye of the inexperienced, appear identical. The first is caused by an animal parasite, the *Strongylus ovis pulmonalis*, the second likewise by a parasite, the *Oesophagostoma columbianum*, both of which require the use of a lense to detect. A description of these parasites may be found in the "Animal Parasite of Sheep," Bureau of Animal Industry, 1890.

In fowls we find that tuberculosis is more likely to affect the abdominal rather than the thoracic organs, but none are exempt. The mesenteric glands, the liver and the genital organs suffer most. In these animals the lesions are peculiar, in that they soon become caseous and calcareous, and it not infrequently happens that these limy nodules reach the size of a walnut. Some are rough and irregular, others are round and smooth. They are quite compact, and upon examining a section it shows yellowish or whitish spots in the centre.

Prevention and Suppression of Tuberculosis in Cattle.

As the disease is incurable we should deal with it with prophylactic measures.

Keep the animals under good hygienic conditions, secure good drainage about the stable, allow plenty of fresh air and sunshine, feed wholesome food and a variety that is nutritious but not over stimulating, supply clean, pure water for drinking. Avoid producing debility by over-milking or by in-and-in breeding or early and late breeding. Reject all animals with an hereditary taint of tuberculosis for breeding purposes. Be careful in selecting animals for the herd, —do not purchase one in poor condition simply because the price is low. It may prove to be a very expensive one in the end.

Do not buy animals from a herd when you know that the disease has ever existed,—it may be present in a dormant state in an animal that is fit for the butcher and only requires certain conditions for speedy growth. Remove from other animals any that you think are suspicious, and keep isolated until pathognomonic symptoms develop. Such animals should in no case be allowed to come in contact with others of the herd by being turned into the yard or pasture with them. They should not be allowed to drink from the same trough or pail.

When one of the herd shows unmistakable symptoms of the disease, it should be slaughtered and the carcass buried or burned. Never let other animals, like pigs, hens or dogs, on the farm, eat the offal or flesh of a tuberculous creature. Anything like the manger or litter, about a diseased animal, that may have become contaminated with the virus should be burnt or thoroughly disinfected.

If young animals are raised upon a farm where tuberculosis exists among the cattle, they should be kept in a separate building away from the older ones, and not be allowed to come in contact with any of the excrements or litter used about them. A case is on record where a number of pigs contracted consumption by eating corn that had passed undigested through the alimentary tract of affected cattle.

Milk from a tuberculous herd, which is to be used as food for young, growing animals, especially calves, should be sterilized by being heated to a temperature of 185° F. This can be done without injury to the milk by subjecting it to the action of steam in a closed vessel. In some animals milk so treated may produce indigestion and constipation, but by careful and judicious feeding these may be prevented.

The liberal and repeated use of antiseptics and disinfectants about an infected building will destroy many of the germs, and assist in checking the spread of the disease in the herd. The floors and mangers may be sprinkled once in a week or two with a five per cent. solution of crude carbolic acid. Chloride of lime scattered over the floor would have a beneficial effect. The walls should be thoroughly whitewashed, and some advise adding to the whitewash a weak solu-

tion of corrosive sublimate. As this drug is a deadly poison, it should be used with great care. By fumigating with sulphur or chlorine, germs that would not be affected by the other applications would be destroyed.

Never allow a person suffering with consumption to work in a stable where cattle are kept, for, by expectorating material which contains bacilli upon the floor or upon the hay, the animals may become infected.

When we stop and think that this terrible disease exists among all civilized people, and more or less among cattle and other domestic animals it does not seem probable that it can ever be exterminated. But much can be done by laws properly enacted and rigidly enforced to prevent the rapid distribution of it among the cattle in the State.

Being a disease that is common to the human race as well as domestic animals, and one widely distributed, it cannot be dealt with as can contagious pleuro-pneumonia. Such a procedure would require an expenditure of millions of dollars and in the end would amount to nothing, for it would be impossible to refill the stables of the farmers with cattle from a source where the disease does not already exist. Again, if all the diseased animals were to be slaughtered and their places filled with those free from the malady, they would not remain so long for they would soon become infected from coming in contact with tuberculous persons.

A law, properly enforced, that would compel an owner to slaughter, rather than to allow him to sell, an animal which he had good and sufficient reason to know was tuberculous, would greatly lessen the dissemination of the disease.

I have personal knowledge of several instances, where it has been proved to men that their herds were badly infected; but instead of destroying the affected ones they have disposed of them for a small sum and the disease has been carried into previously healthy herds.

If it is the work of the Cattle Commission to look after the contagious diseases among the domestic animals of the Commonwealth, they should be given the authority to go ahead and isolate suspicious cases, and destroy those that they know are affected; and every farmer that has any true interest in his calling should be willing to assist in the good work which, in the end, will be of great benefit to every inhabitant in the Commonwealth.

Again when we look at the subject from a sanitary point of view, every person in the State has an interest and has a right to demand protection at the public expense from this deadly foe.

If the State takes upon herself the task of protecting the public from the sale of adulterated articles of food, which are of pecuniary interest, ought she not to protect the people from the wilful sale of

milk and meat from diseased animals, that may convey a fatal disease to the unsuspecting ones using it?

It would seem that this could be accomplished best by two means.

First, Organize a system of meat inspection, have all cattle in the State used for human food slaughtered under competent inspection. To do this economically, centralization of the slaughtering is absolutely necessary. This would not only protect the public against tuberculous meat, but also against that containing trichina, tape worm, actinomycosis, etc. Let all meat be condemned, whether there be local or general infections.

Second, To prevent the sale of tuberculous milk, let all dairies be visited periodically, and all animals carefully inspected. Any that are actually diseased should be destroyed, and the suspicious should be isolated until known to be diseased or healthy. From the fact that the public is so dependent on domestic animals for a part of its food supply, it is no more than right that the government should make some move in this matter of protecting the people against a disease that may be transmitted to them by the consumption of meat and milk of diseased animals.

NOTE. — Persons in the State who may have at any time pathological specimens or parasites which they may want examined, free of charge, may send the same addressed to Dr. James B. Paige, Amherst, Mass., and a report upon the nature of the specimen will be sent if so desired; a detailed account of the case should accompany the specimen.

In order that material sent may be in a condition to study when it arrives, observe the following directions:

Fluids suspected of containing tubercle bacilli, or other germs, should be sent closely corked in a clean bottle. Only a small quantity of matter, one-half to four teaspoonfuls is needed.

Parasites or diseased tissues should be well washed, put in clean, large-mouthed bottles or jars, then covered with a mixture of alcohol one-third, and water, two-thirds.

Specimens of diseased bones or other hard structures may be sent without any previous treatment.

In all cases when there is a large quantity of material, all of which cannot be sent, select an average sample.

When a specimen is of sufficient interest, it will be preserved in the museum with the name of the donor affixed.